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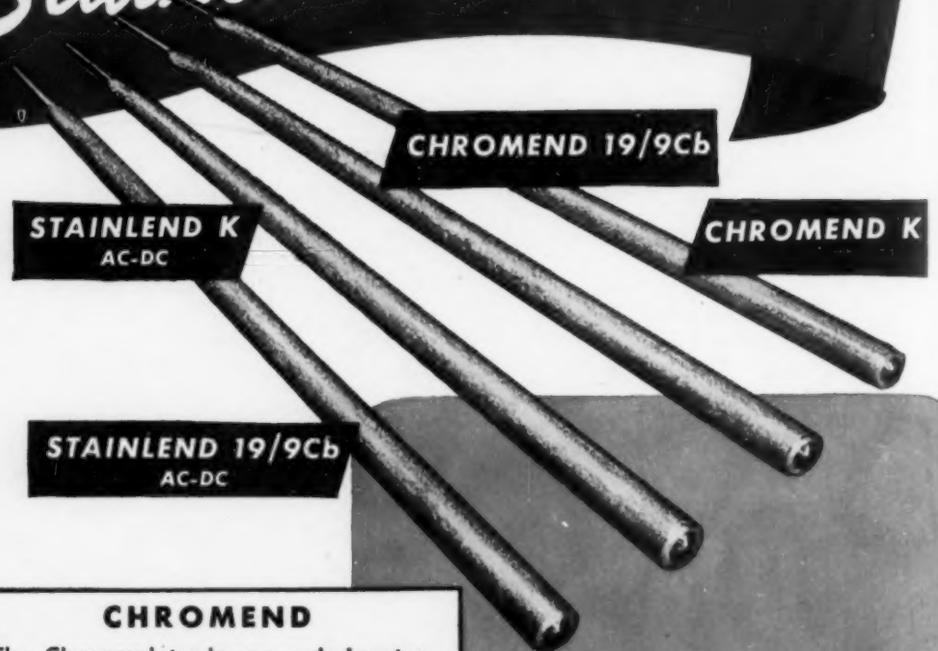

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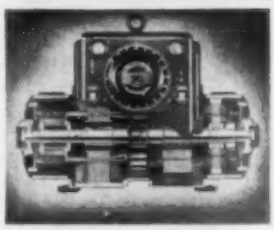

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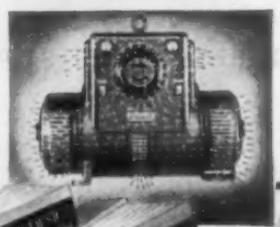

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APRIL, 1946

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Welding a Pipe Line. *Courtesy National Tube Company.*

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Flame Cutting, Flame Hardening and Welding on Railroads*

By J. W. Kenefic†

ONE major railroad is making a very large saving by using old car axles in the production of more than one thousand equalizers for replacements on passenger cars.

Figure 1 shows a large top and bottom bending die which was cut out on the Travograph and which was used to bend the car axles into the proper shape before forging them to size.

Figure 2 shows 120 car axles bent and ready for forging. On the skid is shown two axles forged and ready for cutting.

Figure 3 shows the forged axle being cut on the Travograph and no machining is necessary other than on the wearing surface of the equalizer where four equalizers

* Scheduled for Twenty-Sixth Annual Meeting, A.W.S., October 1945.
† Supt. Railroad Service, Air Reduction Sales Co.

Fig. 1

Fig. 2

Fig. 3

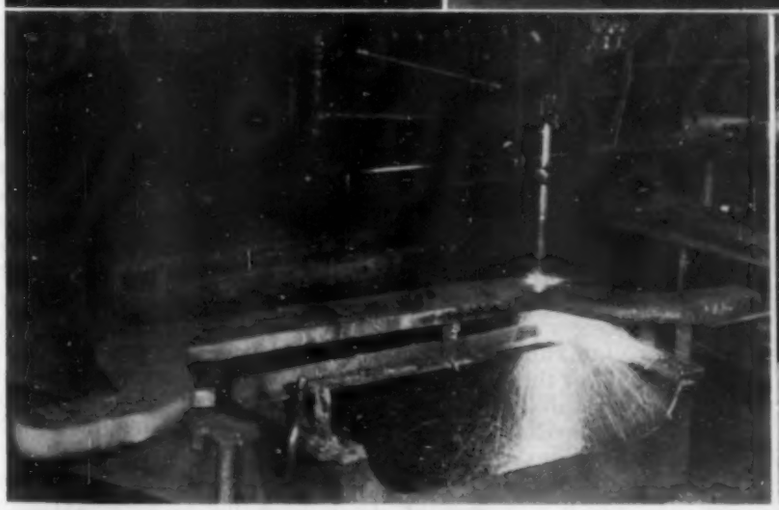
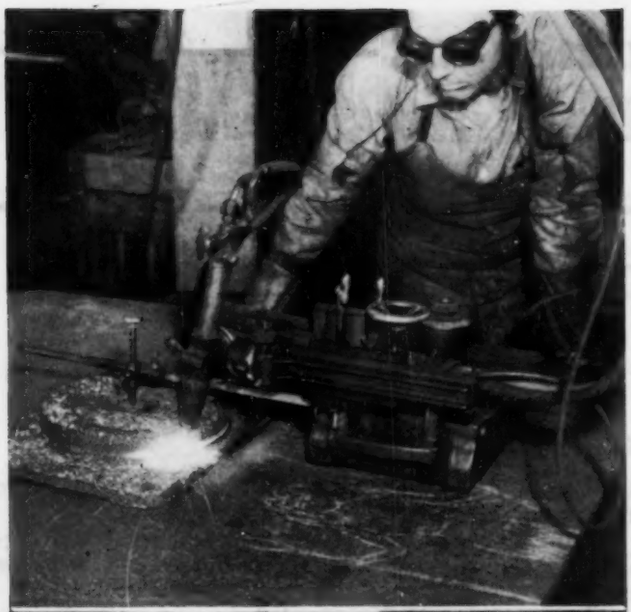


Fig. 4

Fig. 1—Bending Axles in Bending Die
Fig. 2—Axles Ready for Forging; Four Axles with One End Forged; Two Axles Forged, Ready for Flame Cutting
Fig. 3—Forged Axle Being Cut on Travograph
Fig. 4—Four Equalizers Out of Furnace, Ready for Tempering



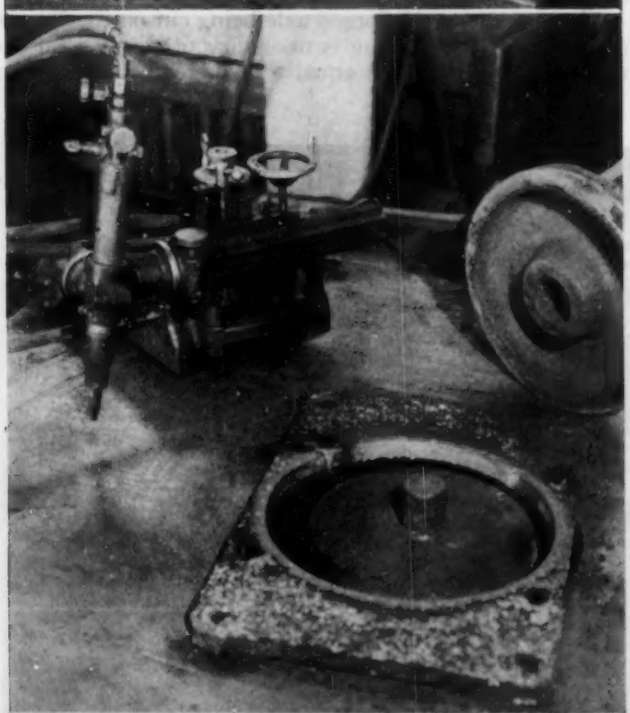


Fig. 5—(Top) Radiagraph Burning Off Flanges Around Center Bowl

Fig. 6—(Center) Plate Cut Out, Ready for Welding to Car Underframe

Fig. 7—(Bottom) Underframe of Car, with Plate Welded On

are machined on the bearing at one time. All equalizers are preheated to approximately 1100° before flame cutting. After flame cutting, the equalizers are normalized at 1625°, reheated to 1500 to 1550° and quenched in oil.

Figure 4 shows four equalizers removed from the furnace and ready for tempering. After the quenching operation, they are again reheated to about 1100° and held at this temperature for approximately $1^1/_2$ to 2 hr. By following this practice, a Brinell of 200 is obtained. Equalizers which show a Brinell of 217 or greater are re-tempered for a lower Brinell, while those that Brinell under 179 are rejected, and in the event they cannot be brought up to the desired hardness, the equalizer is scrapped. This equalizer which is normalized, quenched and tempered is being produced for about one-half the normal cost.

The physical test of the equalizer material, S.A.E. 1045, is listed below:

Carbon	0.48%	Phosphorus	0.013%
Manganese	0.72%	Sulphur	0.027%

	Forged	Normalized	Quenched	Quenched and Tempered
Yield point	49,700	43,300	68,000	54,400
Tensile strength	98,450	85,200	106,400	94,400
% Elongation in 2 in.	1.30	24.0	16.0	28.5
% Reduction in area	14.4	35.9	34.7	56.0
Brinell	196	163	207	179
Izod average, ft.-lb.	9.2	13.2	177.7	29

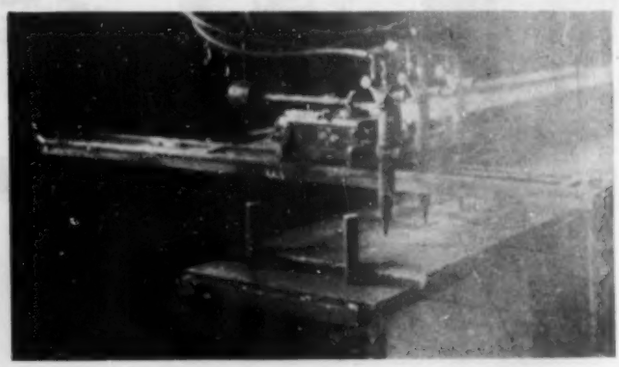


Fig. 8—Radiagraph Cutting Switch Point Slide Plates

Figure 5 shows another effective cutting and reclamation operation. This same railroad, in order to save critical material, has developed many unique ways for salvaging defective car and locomotive parts. One of the items that has proved economical and satisfactory is the reclamation of drop-forged or cast-steel body center plates which generally fail through the rivet holes or the flat portion around the center bowl. The photograph shows the Radiagraph in process of burning off the flanges around the center bowl. Figure 6 shows the plate cut out on the bevel ready for welding on the center sill of the car underframe as shown in Fig. 7. This application provides a complete welded structure, thus eliminating the rivets which have been found to work loose in service.

Figure 8 shows the cutting of switch point slide plates which was necessary to develop due to wartime conditions. These plates were formerly purchased from an outside supplier and were completely finished when received. When these plates could no longer be obtained from the supplier, it was found that they could be obtained from the steel mills in 30-ft. lengths already shaped but would have to be cut to the desired width. Rather

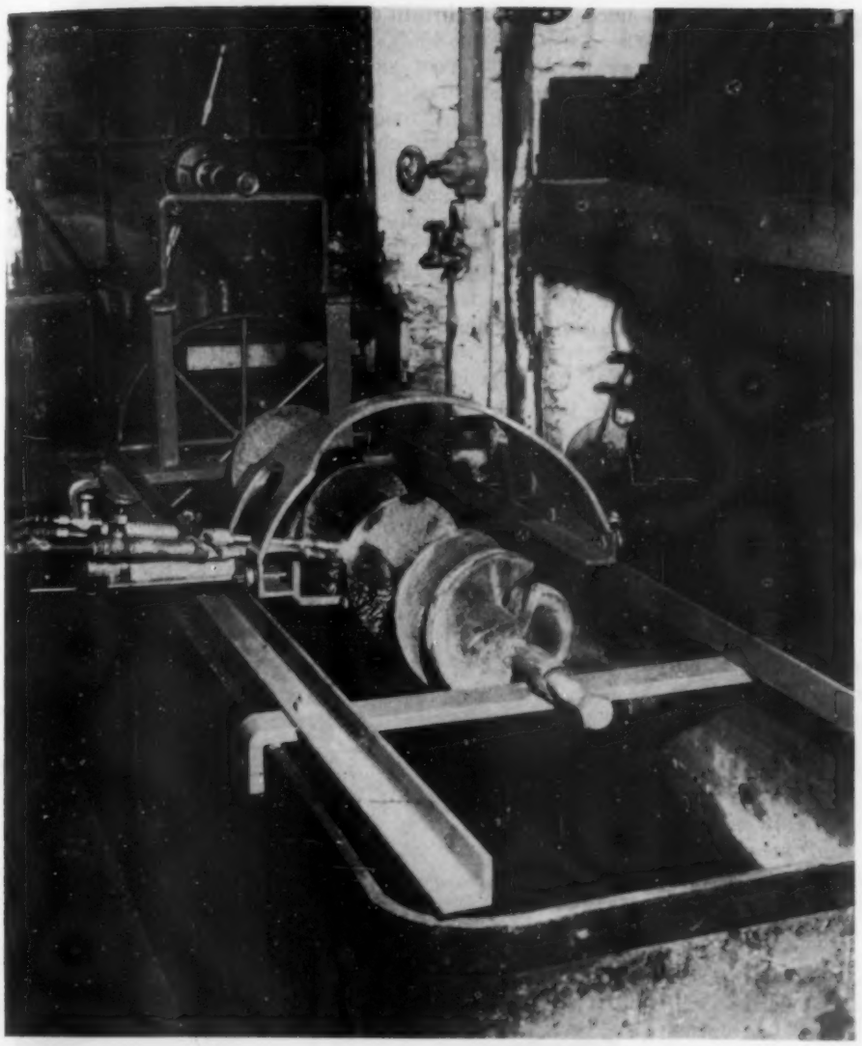


Fig. 9—Built-Up Elevator Screw Being Flame Hardened

than machine to the desired width, it was decided to cut these plates with a Radiagraph using multiple torches. Three torches were mounted on the Radiagraph and three plates were cut simultaneously at a production rate of 550 plates in an 8-hr. day with one operator and a helper. This represents a very substantial saving over previous methods and will be considered as a standard operation in the future.

Figure 9 shows an elevator screw built up and being flame hardened. Conveyor and elevator screws on locomotives receive considerable wear, but by building up these stoker screws with the oxyacetylene welding process and then flame hardening, they generally outwear, two to one, the screws that are not flame hardened. The screw flight should first be built up with the oxyacetylene process with a high-carbon welding rod, and then the surface finished to size with an air or hand hammer. The screw should then be placed in a vertical position and the wearing side of the flight built up to a standard with the electric arc welding process, using a cast-iron rod or a hard surfacing welding rod. After the welding operation has been completed, the flight should be ground or machined to the proper height in preparation for flame hardening. The photograph shows the stoker screw set up in a simple jig which rotates it over a water tank while a control flame plays on the flight, travelling continuously as the screw turns. A water quench follows the flame to harden the screw. The photograph shows an air motor mounted on a bracket support, using a small pulley 2 in. in diameter belted to a larger pulley 30 in. in diameter to revolve the stoker screw at a rate of about 8 to 12 in. per minute. The bracket for support of the motor is mounted over the tank containing the water used in the flame-hardening operation.

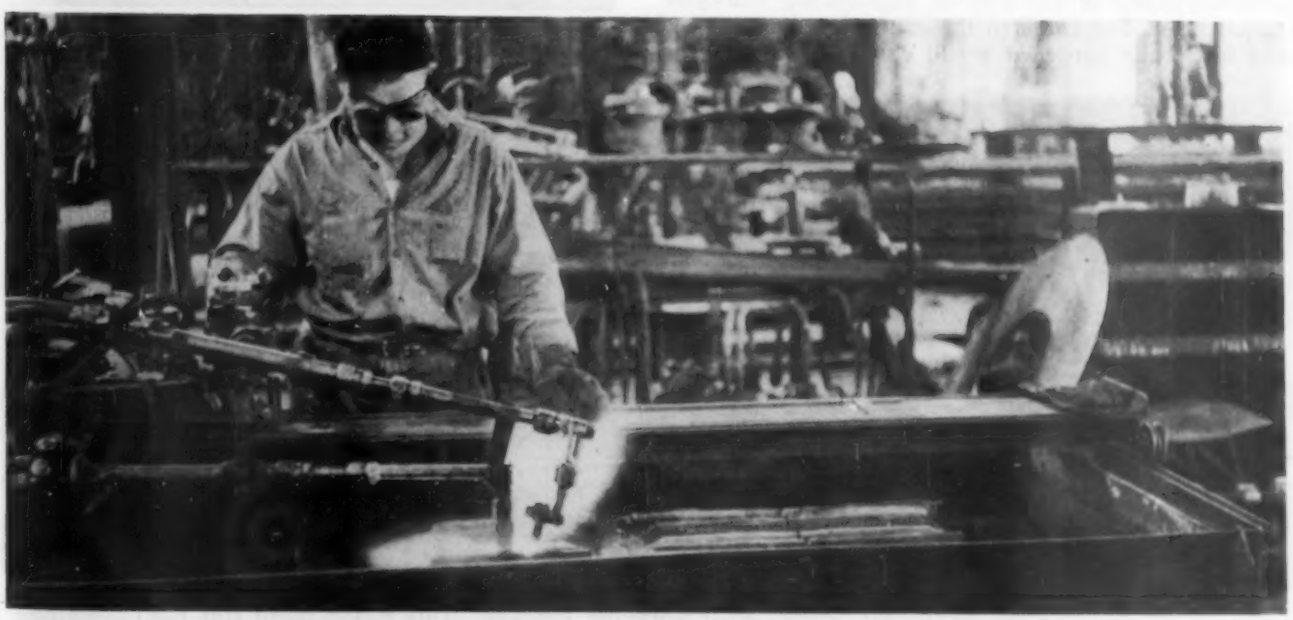


Fig. 10—Three Journal Boxes Being Flame Hardened Simultaneously, with 2-Torch Setup

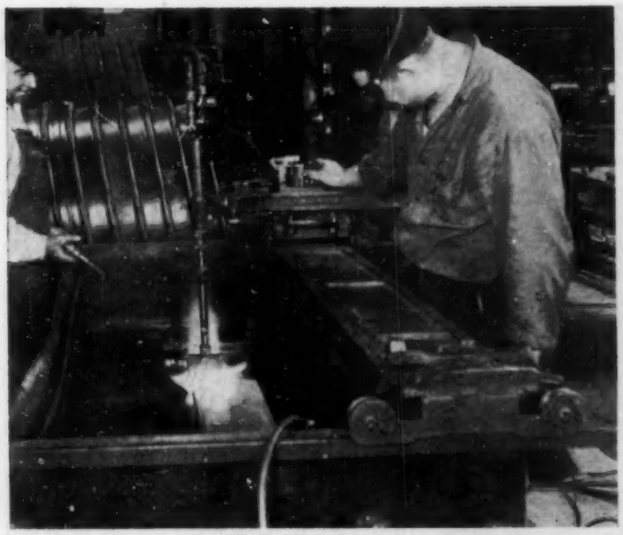


Fig. 11—Flame Hardening a Locomotive Guide

The jig is mounted on two 3- x 3-in. angle irons spaced across the tank with two 2- x 3-in. bar stock pieces supporting the frame of the jig and the motor bracket. The jig is run on the angle iron with four grooved rollers. This jig also has a bracket attached to support a standard welding torch and a copper tube with $^1/_2$-in. globe valve. The copper tube is reduced at the exit end to give a spray of water on the heated area. The torch bracket is assembled with a worm feed to allow the operator to adjust the position of the torch and water spray, both horizontally and vertically. The jig also has a roller attachment on an arm guiding the torch and water spout along the flight of the screw as the air motor revolves the screw.

The depth of penetration of the flame is approximately $^3/_{16}$ to $^1/_4$ in. The average hardness of the flame-hardened screw showed a Brinell of 450 to 500. The flame-hardened torch with five flames operates at a speed of about 6 to 8 in. per minute.

Figure 10 shows a very interesting flame-hardening operation on passenger coach journal boxes. Malleable passenger coach journal boxes are a regular repair job for all railroads. One major railroad has made a very concentrated study of the cost of maintaining malleable journal boxes and came to the conclusion that a cast-steel box flame hardened would eliminate the expense necessary to maintain a malleable box. Cast steel boxes, $5^1/_2$ x 9 in., of 45–55 carbon for flame hardening, are available at a cost slightly higher than the malleable boxes formerly used. These cast-steel boxes are received in the rough and, to eliminate the cost of the use of a shaper, a milling machine has been designed to machine the total surface of the pedestal ways in one operation. After these cast-steel boxes are machined, a test of Brinell hardness generally shows 190 to 200. The flame hardening of the pedestal ways is a very simple operation, requiring two flame-hardening torches with tips to cover the ways on top, bottom and sides in one pass. The photograph shows three boxes being flame hardened progressively at one time. The same equipment and tank are used for other flame-hardening operations. The pedestal ways, after being flame hardened, are increased from Brinell 190 to 500 but the rest of the journal box has all the strength of any mild steel casting. An-

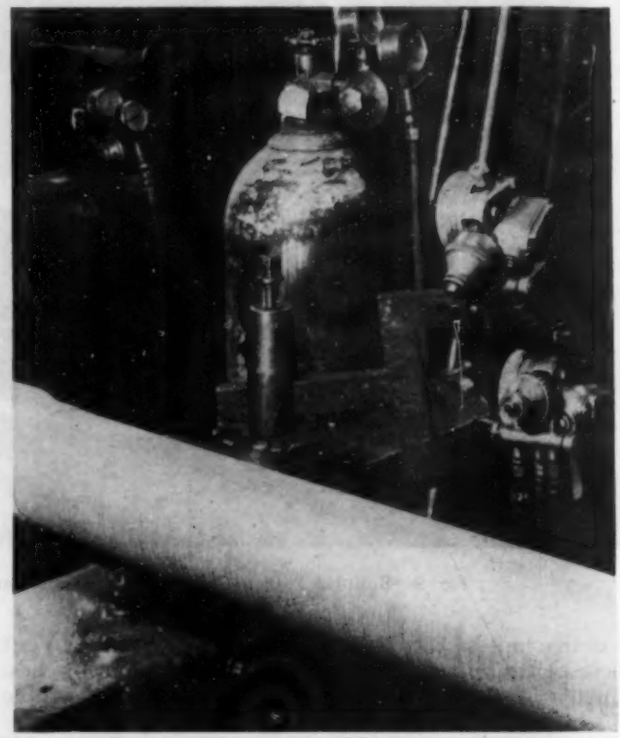


Fig. 12—Preparing to Double the Life of a Piston Rod by the Metal-Spraying Process

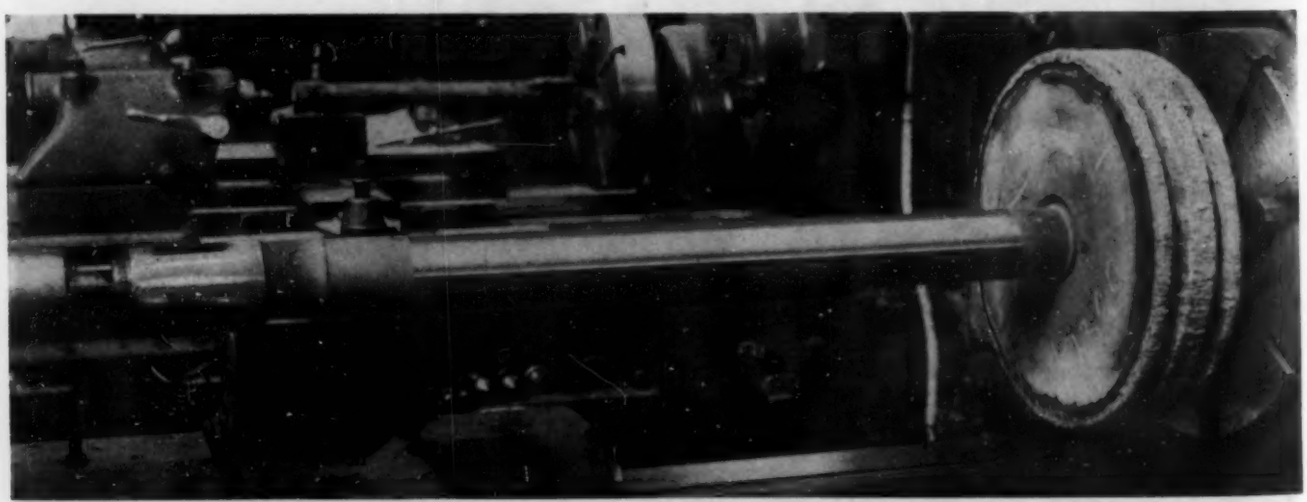


Fig. 13—Piston Rod Practically Machined, After Spraying Process. This Piston Head Has Also Been Reclaimed by Being Built Up with a Manganese Welding Rod

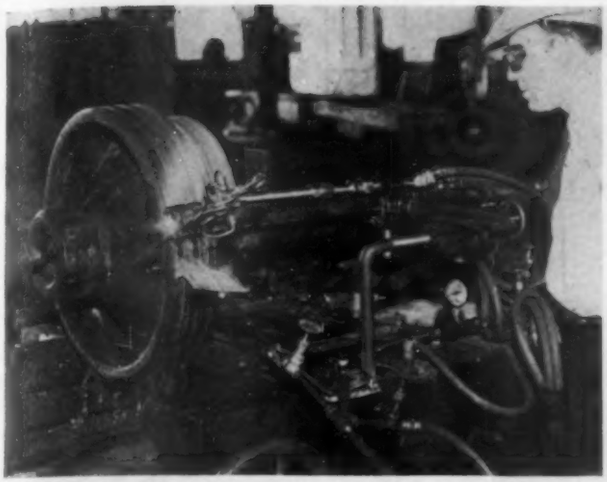


Fig. 14—Flame Hardening Walls of Piston Head Ring Grooves, Using Special Multiflame Tip. Assembly Is Placed Between Lathe Centers

other advantage that will reduce costs in the future after the journal boxes become worn is the fact that they can be rebuilt with a suitable rod, machined and flame hardened repeatedly for years.

Figure 11 shows flame hardening of a locomotive guide, which is perhaps one of the easiest flame-hardening operations. Locomotive wearing parts are constantly in the minds of the officials and mechanical men maintaining power. In flame hardening the guide, the first consideration must be given to the steel. To get the Brinell range, steel must be in the medium carbon class—S.A.E. 1045 to 1055. Since carbon steels are used most commonly for locomotive guides, they can be flame hardened without too much consideration of thermal checking. Distortion is the second consideration but can usually be controlled within a maximum of ten-thousandths. The guide is flame hardened on the edges and face at a speed of between 4 and 6 in. per minute, giving a Brinell hardness of 500 to 650.

Figure 12 shows a very interesting metal spraying operation being done on one of the large western railroads.

Fig. 15—Removing a Rivet Head with Ordinary Tip

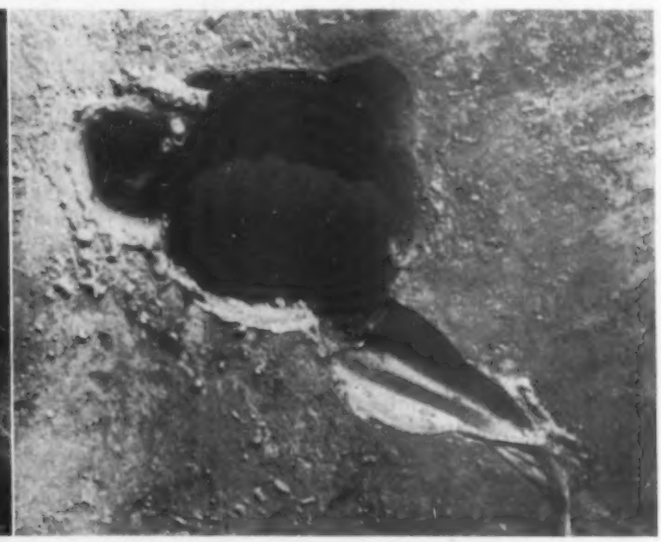


Fig. 16—Poor Condition of Hole and Sheet After Same Rivet Has Been Backed Out

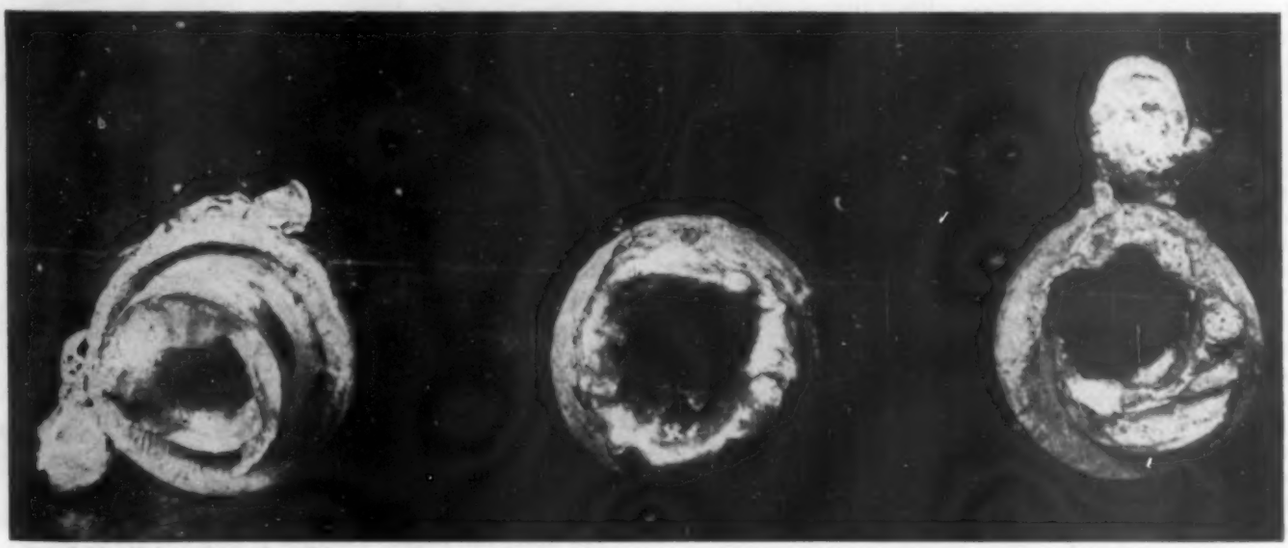


Fig. 17—Condition of Rivets After Being Completely Pierced with Ordinary Tip

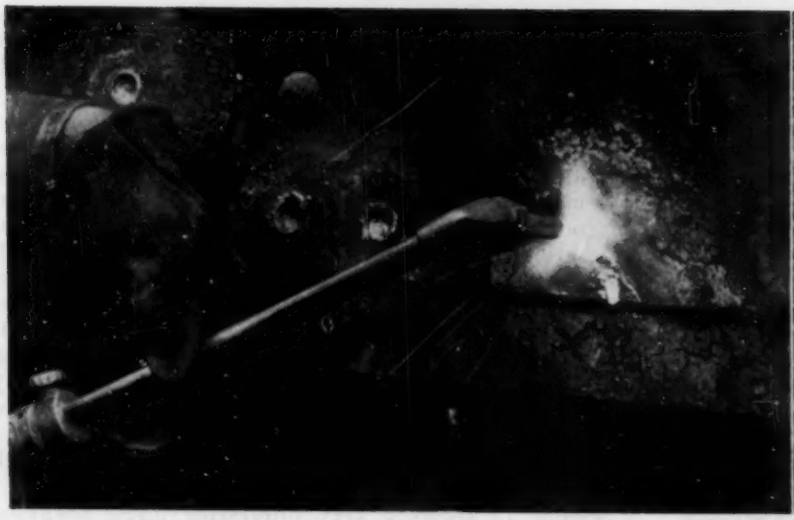


Fig. 18—Airco Style 144 No. 12 Tip at Work on a Rivet Head

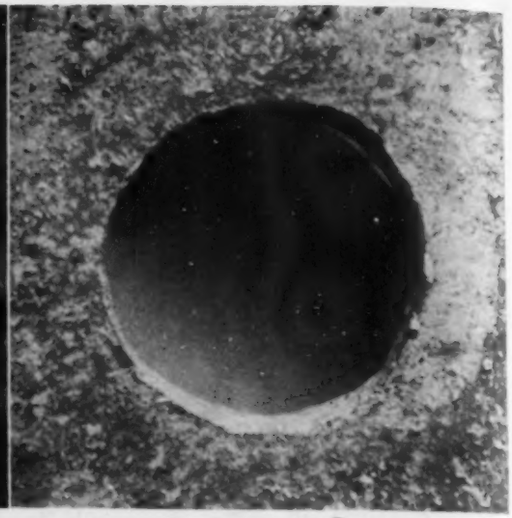


Fig. 19—Clean Appearance of Hole, After This Rivet Has Been Completely Removed

The photograph shows the application of the metal spray process as used for reclaiming of piston rods of all classes of power. The reclamation of these piston rods represents a very appreciable saving, especially in view of the fact that a rod so processed will have more than double the service life of a new one. This is possible because the wire used in the spraying operation had a carbon content of 0.80 and has a hardness ranging from 550 to 600 Brinell, while on the parent metal the hardness is about 180. Further, lubrication is obtained due to the porosity of the sprayed deposit. A check was recently made of metal-sprayed rods which had been in service for 18 months on Mallet type locomotives and the wear averaged six-thousandths, which is about one-third the wear that occurs during the same time on a new piston rod. As indicated in the photograph, the rods are prepared for spraying in the following manner. A No. 14 thread, tool width 0.045, thirty-thousandths of an inch deep, is cut on the rod extending 12 in. beyond stroke. A knurling tool is then passed over the top of the thread, pressing it down five-thousandths; this produces an interlocking effect upon the sprayed metal. Care must be taken that no grease or oil gets on the rod after preparation. Time for preparing the rod averages about 4 hr.

For the spraying application the rod is mounted in a lathe which is also equipped with a fume-collecting device. The rod is then rotated and two spray guns mounted on a tool holder are put in operation. The feed is set at about 2 ft. per minute and about two- to three-thousandths of an inch of metal is applied on each pass, depending on diameter of rod. This operation goes on continuously until the desired diameter is obtained. The spray gun uses approximately 130 ft. of oxygen per hour and about 100 ft. of acetylene. The time for spraying depends entirely upon the size of the rod but averages about 6 hr.

The rods are machined in two cuts, using a carbide tool. Some questions undoubtedly will arise about machining because of the hardness involved but this is possible due to the granular condition of the deposit.

Figure 13 shows the piston rod practically machined. It also shows the piston head reclaimed by being built up with a manganese welding rod and applied by the oxyacetylene process. This is one of the many important operations that is being done today in most large railroad shops. The average time for reclaiming the ordinary piston rod is about 18 hr.

Piston head ring grooves are subjected to a peculiarly severe wear, in that the piston rings are forced from one side of the grooves to the other, with an alternating pressure being exerted against the walls of the grooves. Because this quickly impairs the efficiency of the piston, calling for replacement of the piston head, flame hardening seems to be the logical answer once more. The *amount* of wear on these parts swiftly increases the *rate*

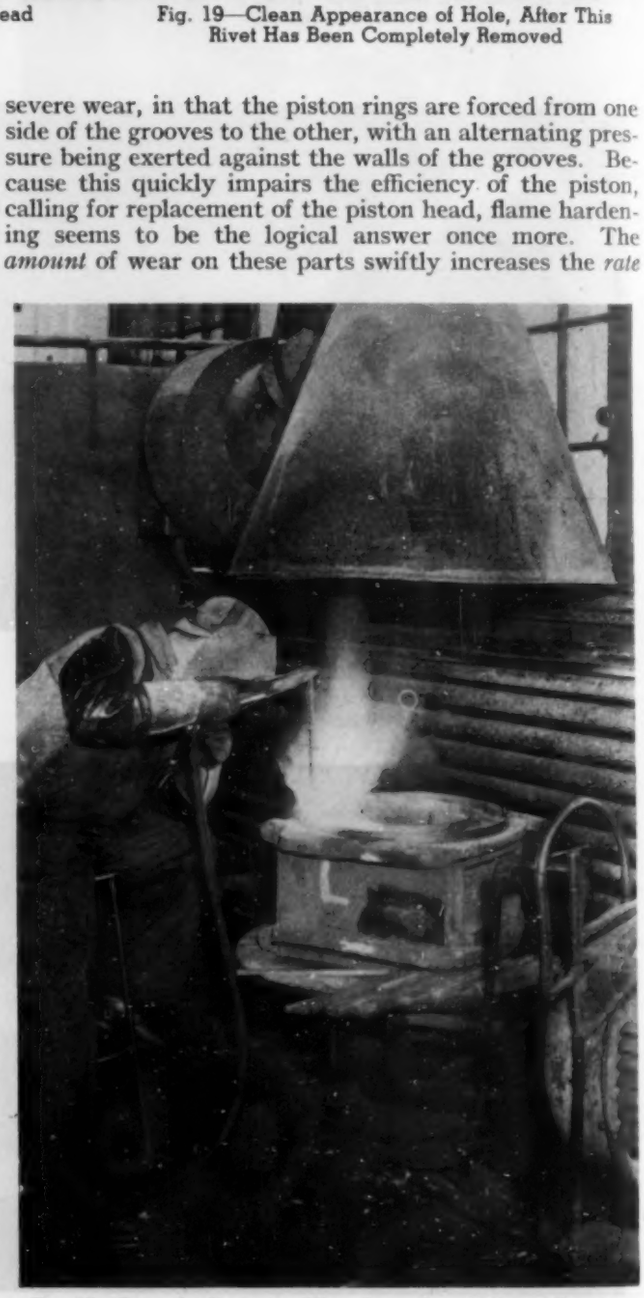


Fig. 20—Setup for Restoring Worn Laterals with No. 19 Bearing Metal by Electric Arc

of wear, due to the severe conditions under which piston ring grooves exist. This wear is materially reduced by hardening the walls of these grooves.

Since the wear on a ring groove is a gradual one, and occurs from the top of the wall downward, it is the top of the wall that must be flame hardened, downward to a distance of from $^1/_2$ to $^3/_4$ in. The depth of hardening is about $^1/_8$ in.

A simple setup for this operation is possible by mounting the piston head on a piston rod and placing the whole assembly between lathe centers. The lathe is then geared to rotate the head at a constant speed, which will, of course, vary with the size of the head and grooves. Heat and speed may be adjusted to give the desired depth of hardness; a recommended speed is one that rotates within a range of 4 to 8 in. per minute.

Figure 14 shows this operation using a special oxy-acetylene multiflame tip. This tip is actually three separate multiflame tips, each of which heats and quenches both walls of one groove simultaneously, thereby making possible the treating of six walls in one operation.

The tip is held by a torch-adjusting arm on a No. 4 Radiagraph, which permits the fine adjustments necessary to position the tip in the grooves. Piston heads of 26 in. diameter are hardened in this setup at a speed of $6^1/_2$ in. per minute; these heads, for example, are completed in 12 min.

Approximately 30 cu. ft. of acetylene and 33 cu. ft. of oxygen were used in treating these heads. The surface hardness will depend on the analysis of the material, but generally a hardness of 450 to 550 Brinell is desired.

This procedure has become standard in flame-hardening practices, and this particular setup is a simple one, demanding a minimum of equipment, and of setup time. At least one railroad equipment manufacturer has been using this process in hardening piston head grooves for at least 2 years, following the specifications of railroad customers, which assures these customers of longer life and reduced maintenance on these heads.

At one time, rivets were removed by the old "rivet buster" method, which required three men to handle the operation, and was comparatively dangerous since it filled the air with the flying rivets and rivet heads being cut off and punched out. This method was improved upon by employing a flame to slice off the head and cut the full length of the rivet. However, frequent nicking, elongation of holes, and scoring of the sheets or castings as the result of using ordinary tips, led to the design of a tip made specially for this purpose.

By following proper procedure, and by employing an Airco Style 144 No. 12 tip, these imperfections are eliminated. Rivets may be pierced to a depth of $^1/_4$ to $^5/_8$ in., then easily removed by the use of a riveting hammer similar to the Boyer No. 80.

Figure 15 shows the operation of removing a rivet head with an ordinary tip and the former slicing method, an operation which makes almost inevitable scoring of the sheet.

Figure 16 shows the condition of the hole and sheet after the rivet has been backed out. To avoid such scoring of the sheet, a complete piercing of the rivet, using an ordinary tip, to burn it out of the hole, has often been resorted to, but which also leaves poor holes; the condition of these rivets, after being so pierced, is shown in Fig. 17.

None of these results can compare favorably with those obtained by the use of our No. 12 tip, which is particularly suitable for this work. The No. 12 tip successfully handles the $^5/_8$-, $^3/_4$- and $^7/_8$-in. rivets, which are used extensively in car construction.

Figure 18 shows a Style 144 No. 12 tip being used to remove a head, and to pierce the body of a rivet for easy removal, work for which the tip was developed.

The appearance of the rivet hole after removal of the rivet is shown in Figure 19—a clean, flawless job.

On a recent rivet-piercing test, 1976 rivets were pierced in two cars in 9 hr., 54 min., with a total oxygen consumption of 1727 cu. ft., total acetylene consumption of 391 cu. ft., and at a total cost of $29.20, or an average cost per

Fig. 21—Procedure Used in Restoring Laterals by Carbon Arc Method

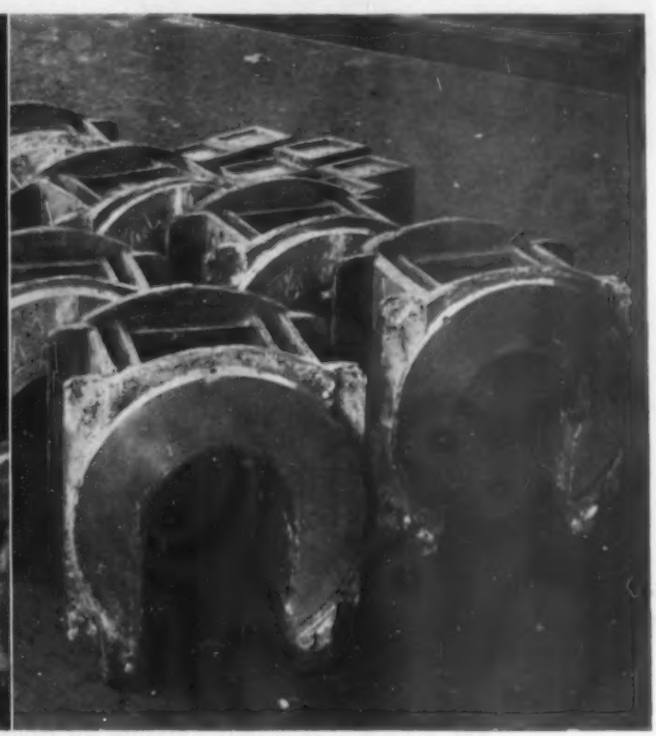


Fig. 22—Group of Restored Laterals After Machining

Fig. 23—Placing an Initial Deposit of No. 20 Bronze on an Engine Truck Box by Oxyacetylene Process, to Be Followed by Main Deposit of No. 19 Bronze by Arc Welding

car of $14.60. (This figure includes the costs of cleaning by labor and cutter.) Our Style 144, No. 12 tips were used, with acetylene of 7 to 10 lb. operating pressure, and oxygen of 20 to 25 lb. operating pressure.

A self-fluxing, lead bronze welding rod, known as our No. 19, is being used to good advantage in several repair operations. Number 19, specially designed for surfaces of locomotive parts which are subjected to very severe conditions, may be directly welded, by electric arc, to cast, forged or rolled steel, brass or bronze. Its analysis is substantially the same as that of the brass which is usually poured in on driving box laterals. The physical and chemical properties of this rod are very close to those of S.A.E. 64 and S.A.E. 67, as shown in the following table:

Specifications

Basic Elements	S.A.E. 64	S.A.E. 67	Airco No. 19 Rod
Copper	78.5–81.5	76.5–79.5	78.5–80.5
Tin	9.0–11.0	5.0–7.0	7.1–8.1
Lead	9.0–11.0	14.5–17.5	11.5–13.5
Zinc, etc.	1.0–Max.	2.0–Max.	1.5–Max.
Brinell, 500 kg.	60–70	48–52	48–52

Fig. 24

Fig. 25

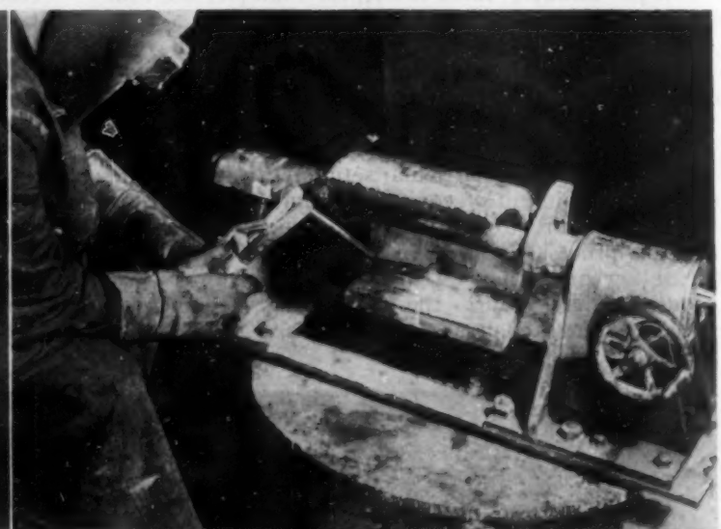


Fig. 26

Fig. 27

Fig. 24—Laying Main Deposit of Bronze Rod Over Initial Deposit by Arc Welding
Fig. 25—Simple Rotating Fixture for Holding Crown Brass While Being Restored
Fig. 26—Engine Truck Box and Crown Brass Rebuilt with Bronze Rod. Lateral Has Been Machined
Fig. 27—Crown Being Restored on Driving Box Designed for Full Weld Deposited Laterals and Crowns

This No. 19 will give equally good results whether deposited by the carbon arc or by the metallic arc method. A short arc should be maintained to cut down gas inclusions, current should be adjusted properly to assure good penetration, and the surface should be cleaned, as any rust or oxide on steel surfaces will affect the bond and cause slag to occur. A 600-amp. machine is required, with a $^{7}/_{8}$- to 1-in. carbon rod, operating at 550–650 amp.

In the maintenance of cast-steel engine truck boxes, the procedure is the same as for the repair of driving boxes with the use of No. 19. A metal form of $1^{1}/_{8}$ x $^{1}/_{8}$-in. bond iron is tack welded into place to hold the weld to a desired shape. This maintenance of weld may, if preferred, be done with a dam of wet asbestos. The box is mounted on a rotating table to facilitate faster welding; the table is driven by an air motor. A 400-amp. welder is used, with $^{7}/_{16}$-in. bronze rod. The deposit, in being built up to a height of at least $^{1}/_{2}$ in., should be a smooth, regular weld, to avoid holes or depressions after machining.

The bronze should be applied in layers of $^{1}/_{8}$ in., and an allowance of $^{1}/_{16}$ to $^{1}/_{8}$ in. is customarily left for machining. The layers are applied in sufficient number to leave the required depth of deposit after machining.

Figure 20 shows a setup for building up a lateral with No. 19 bearing metal by electric arc process. Note retaining ring of $^{1}/_{8}$-in. band iron.

Care must be taken that the assimilation of the steel into the bronze does not progress too far, in order that hard spots are not created on the surface which would score mating parts. The building up of additional height on the lateral or the making of a $^{1}/_{16}$- or $^{1}/_{8}$-in. undercut will compensate for the mixing of the steel with bronze on the initial pass. The deposition rate of this rod is high, so movement must be rapid to assure actual welding because partial fusion of the bronze to the base metal is essential.

Figure 21 shows a setup for building up lateral by carbon arc welding. Driving box rests on a rotating platform.

Figure 22 shows the appearance of welded laterals after finish machining.

If the engine truck box is of cast iron, the procedure differs slightly in so far as the lateral is given an initial deposit of manganese-bronze by oxyacetylne welding to serve as a foundation for the bronze buildup. (This manganese-bronze rod tins with the cast iron very readily.) (See Fig. 23.) Arc welding is then used to lay No. 19 over this foundation, as in Fig. 24. Any future restorations of this lateral may be made without repeating the oxyacetylene initial depositing. This is the only economical method of rebuilding box laterals today.

A similar repair operation is the building up of worn crown brasses, in which the No. 19 rod is again used with good, lasting results; here the bronze is deposited on the back and face of the crown for a distance of 4 to 5 in. The worn areas are restored by building up these two sides with this rod while the piece is held in position by a simple rotating fixture, after which the crown brass is ready for machining.

Figure 25 illustrates this positioner, a cast crown brass being restored.

The brass may be restored while in the box, but this calls for careful heat control, and so if it is removable, the safest procedure is to build up the piece on a fixture, as mentioned above.

Figure 26 shows both an engine truck box and a crown brass built up with No. 19. The lateral on the truck box has been machined.

This application of this rod has proved so successful that some railroads have eliminated the separate crown brasses, substituting an all-weld metal crown which is restored to size after having been subjected to severe wearing conditions. This restoration is accomplished by a procedure similar to that used in restoring laterals. New driving boxes are cast without the usual crown recess. In old boxes having this recess, a section of steel plate is welded into the recess to compensate for some of the space required for the conventional crown brass; then a deposit of this bronze rod is built up over this plate to a height that will allow for a depth of $^{1}/_{2}$ in. in the crown and $^{1}/_{4}$ in. at the sides after machining. Figure 27 shows a driving box designed for full weld deposited laterals and crowns, with the crown being restored.

There is one thing to remember in using No. 19 bronze rod—it contains lead; like similar bronzes, the fumes from this lead are poisonous. It is recommended, therefore, that adequate ventilation and protection be provided the operator.

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(*Continued on page 312*)

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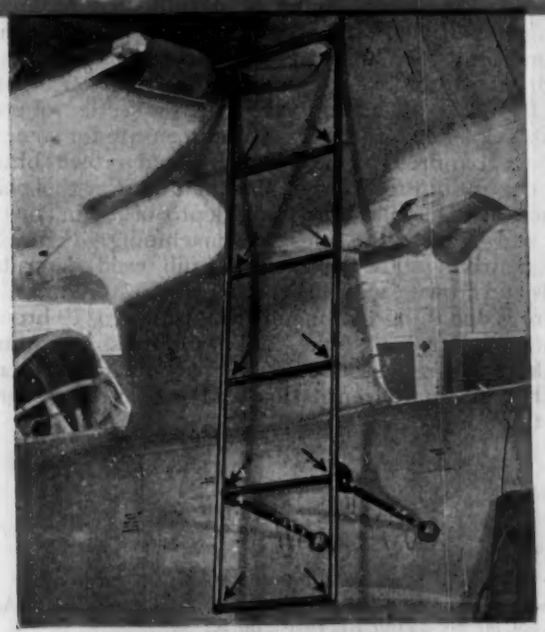
EUTECTIC to the RESCUE at *Curtiss-Wright*



THE SEAHAWK RESCUE LADDER

All parts (tubes and gussets) were set in a fixture and tack welded with EutecRod 16. The ladder was then taken out of the fixture and finished on the bench. This rod produces small fillets and prevents distortion.

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MANY American and British fliers downed at sea owe their lives to this famous Curtiss-Wright SC-1 Seahawk whose rugged rescue ladder was the helping hand that reached out to save them from certain death.

Extending from the fuselage to float the ladder folds into a compact unit. Although simple in design the fabrication was a headache to production engineers at Curtiss-Wright. Preliminary gas welding on the collapsible edges resulted in distortion and misalignment.

To lick this problem, EutecRod 16, which forms strong welds at 1300°-1600° F., was recommended. This low heat of application eliminated all danger of distortion and misalignment. The results obtained with this rod were so satisfactory that now it is also used in the production of control handles, brackets and parts of other planes manufactured by Curtiss-Wright including the latest model Helldiver.

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Atomic Hydrogen Welding in Aviation

By Frederick S. Dever*

NO INDUSTRIAL program has ever equalled the recent war effort in which the United States completely marshalled its industrial capacity and ingenuity to launch a mass production flow of war tools.

In every phase of manufacturing, American industry was tireless in its efforts to uncover faster and better methods for the fabrication of the war products so vitally needed.

In the field of welding, the same terrific progress has been accomplished. Tremendous strides were taken during the war to add new significance to this method of joining metals. Notable examples are the welding of cargo ships, the development of a satisfactory way to weld magnesium, improved welding machines, improved electrodes and a wider knowledge of the metallurgy of welding. Weld failures are now more of an exception than ever before and they can be quickly identified by most technicians.

One interesting phase of this industrial achievement has been in the welding of light-gage materials used in the aircraft industry. Here progress can be measured by increased knowledge of welding design, fuller utilization of existing welding facilities and the introduction of special alloys used in the work.

At the Ryan Aeronautical Co. early use was made of the atomic hydrogen method of welding which was pioneered and developed by the General Electric Co. This had not previously been used to any appreciable extent for the welding of light gages of stainless steel in the fabrication of exhaust collectors, heat exchangers, etc. However, this method of welding had advantages over other processes which had been known for some time. The methods then in use for the majority of the work (oxyacetylene welding) possessed inherent disadvantages particularly harmful to both the ductility and corrosion resistance of this material.

These disadvantages, in the case of stainless steel, consisted of carbon pickup generally resulting from the use of excessive acetylene together with a longer welding time which resulted in a partial loss of the stabilizing elements of columbium and titanium. These elements of columbium and titanium stabilize the alloy and prevent an inter-crystalline breakdown when the finished product is subject to high service temperature.

It was obvious at the outset that the atomic hydrogen method would overcome these two major objections to the oxyacetylene welding process. With the use of hydrogen, which in many respects is the opposite of oxygen, a reducing atmosphere would be present so that any "burning" or severe oxidation, with its resultant ill effects, would not be so difficult a problem. In addition, the temperatures of the atomic arc being so much higher, the time at temperature would also be shortened. This latter characteristic was also very desirable since the corrosion resistance of the material would be improved.

This resistance to corrosion was particularly necessary because of the high service temperatures to which the parts would be subjected. It is a curious corollary that the ductility and corrosion resistance of the 18-8 type of stainless steel are generally closely related so that a weld of good ductility is generally corrosion resistant and vice versa.

The early attempts with the use of the atomic hydrogen welding process had many of the usual stumbling blocks. Some welders distrusted the method, thereby slowing down shop acceptance. To others, the high heat, so great as compared to the oxyacetylene method, resulted in difficulty on the part of the welder in controlling his speed. Too slow a speed would often result in a burning through, necessitating repairs, and in many instances, scrapping of the part. Too fast a welding speed resulted in severe shrinkage of the weld over its length, so that a series of cracks would form across the weld. These cracks necessarily demanded repair welding, again resulting in an unfavorable attitude on the part of the welders and sometimes also the supervisors.

Persistence, together with a careful evaluation of the lessons learned, soon brought forth much interesting and useful information. The "silent arc," namely, the arc obtained when the electrodes are held closely together, permitted of a finer control on thin gages of metal. Using the "singing arc," obtained with the electrodes separated to a greater extent, very often forced the welder to weld so rapidly that cracks would develop because of the severe cooling which followed as the arc passed rapidly over the molten metal.

Another factor which always puzzled the technician as well as the welder was the formation of worm holes almost in the center of the weld running lengthwise with the bead. This trouble has been almost completely eliminated, however. It was caused as a result of too rapid welding in which the metal was not given time to flow flat before it became frozen.

The methods now in use with the atomic hydrogen welding process demand a slower welding speed than was earlier used, yet this is still a little more than twice as fast as the oxyacetylene method. Also the use of the "silent arc" has become standard because of the finer control which is obtained.

Higher hydrogen pressures are used in tacking as well as a higher current since,

Fig. 1—Huge Stainless Steel Exhaust System Manufactured by Ryan for Aviation Engines

* Assistant Manifold Manufacturing Manager, Ryan Aeronautical Co.

as is common in most tacking operations, a high heat is required to bring the metal temperature up quickly so as to develop a small weld without distorting the assembly. Another technique found to be very advantageous is adjusting the tungsten electrodes so that the arc fan can be rotated to almost any desired angle. This flexibility permits a great range of welded joints and will permit the operator to weld ill-fitting parts with more than a fair degree of proficiency.

The following types of joints have been welded with this process: Lap, fillet, butt, flange, seam, edge and corner. Notwithstanding the above-mentioned advantages, many of primary importance, there is still the major function of a welded joint to be considered. We may define this major function as being the final bond obtained after welding is complete, its soundness, strength and fatigue resistance characteristics. In this respect the welds produced by the atomic welding process have proved superior to many other methods of welding and equal to any of the methods now in general use. In many specific applications this process is desired over others.

So far our discussion has concerned the welding of stainless steel. This process has also been used and is now in use in the welding of low-carbon steel sheet compatible with enameling materials. For the welding of these materials, the atomic hydrogen process has offered an excellent means of joining thin gage materials on both irregular and closed angle welding, resulting in welds of good strength and ductility. The welding output per welder has been materially increased because of the greater speed obtained.

This is also proving very desirable because of the narrower weld bead which is obtained. A narrow weld bead is very often desirable in aircraft welding since the soundness of the weld is more easily determined and visual inspection is made easier; together with the fact that a uniform narrow bead commensurate with adequate penetration shows a fine degree of control by the operator. This will usually indicate that the weld metal has not been so severely overheated as to damage the material.

The cost of the atomic hydrogen welding process is lower than the oxyacetylene process because of the greater amount of welding which can be completed in an eight-hour day. About one-third of a cylinder of hydrogen per operator is used daily and the electrode cost is about twenty cents.

The pressure gages used are those which are standard in the welding industry with the slight exception that the working pressure gage is graduated in one-pound divisions. This is not, however, absolutely essential. The electrical cost is quite low. Another factor in cost is the matter of joint preparation. It has been found that by careful manipulation of the atomic hydrogen welding torch, ill-fitting joints, because of the better penetration achieved can be welded quite successfully. Thus the fitting cost can be reduced with resultant saving in the over-all cost of welding.

So far we have mentioned some of the

Fig. 2

Fig. 4

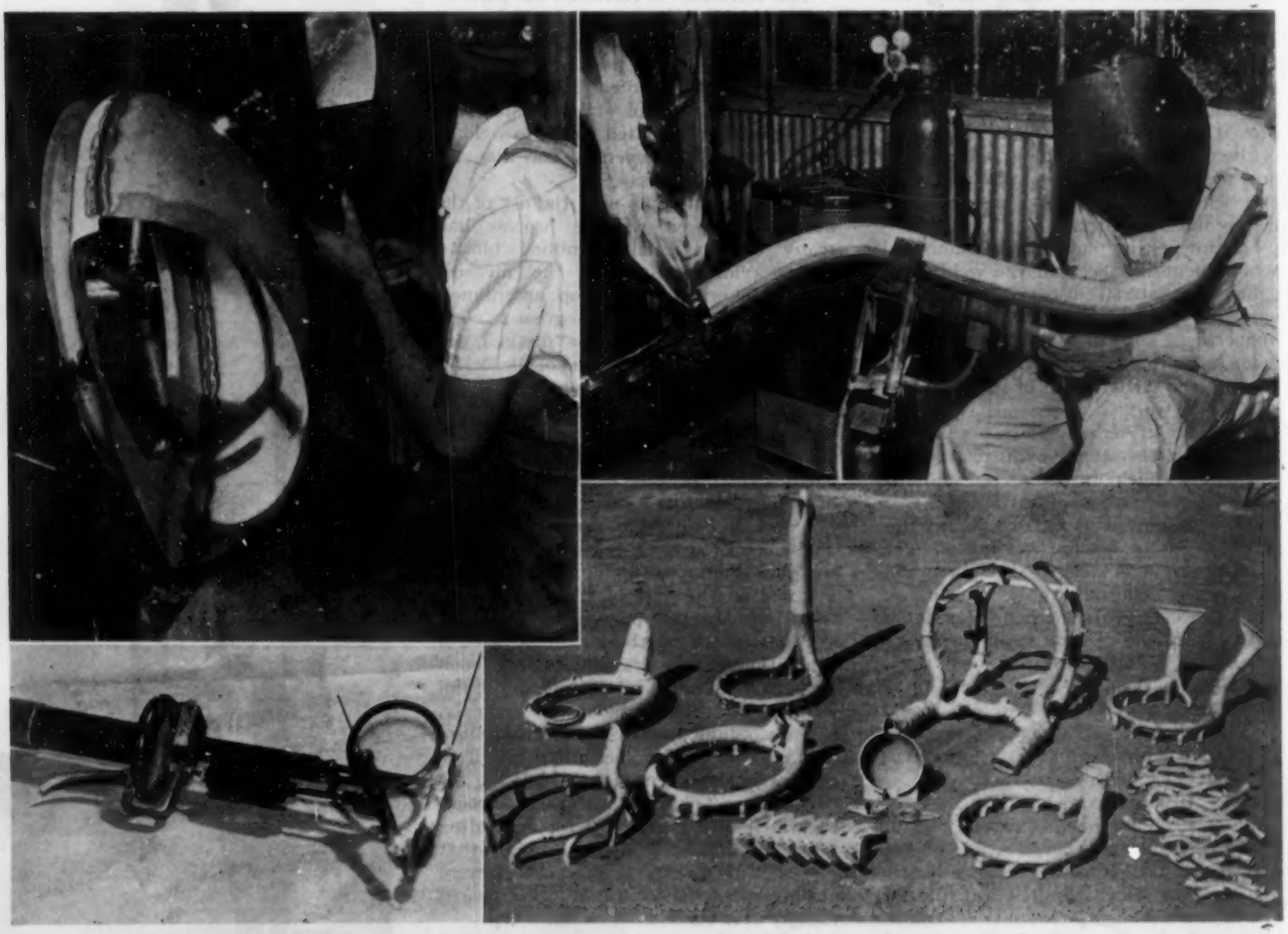

Fig. 3

Fig. 5

Fig. 2—A Ryan "Atomic Speed Queen" Uses Atomic Hydrogen to Weld a Thin-Gage Stainless Steel Part
Fig. 3—Close-up of the Atomic Hydrogen Welding Torch Showing Its Twin Tungsten Electrodes Enclosed in Hollow Sleeves Through Which the Hydrogen Flows
Fig. 4—Ryan Devised This Technique Using Atomic Hydrogen to Weld Closed Sections with Illuminating Gas Being Burned Inside of the Tube to Eliminate the Oxygen Present and Prevent Oxidation of the Inside Weld Seam
Fig. 5—Welded Stainless Steel Structures Which Are Manufactured by the Ryan Aeronautical Company to Convey the Terrific Exhaust Heat from Modern Aircraft Engines

Fig. 7

Fig. 6

Fig. 8

Fig. 6—Close-up of a Typical Oxyacetylene Welding Operation in Which Filler Metal Is Added to This Ryan Exhaust Section

Fig. 7—Close-up of Smooth Weld Seam on Type 347 Stainless Steel Which Was Welded with Atomic Hydrogen at Ryan Aeronautical Co.

Fig. 8—Close-up of Weld Bead on Stainless Steel Manifold Section Showing Worm Holes Caused by Too Rapid Rate

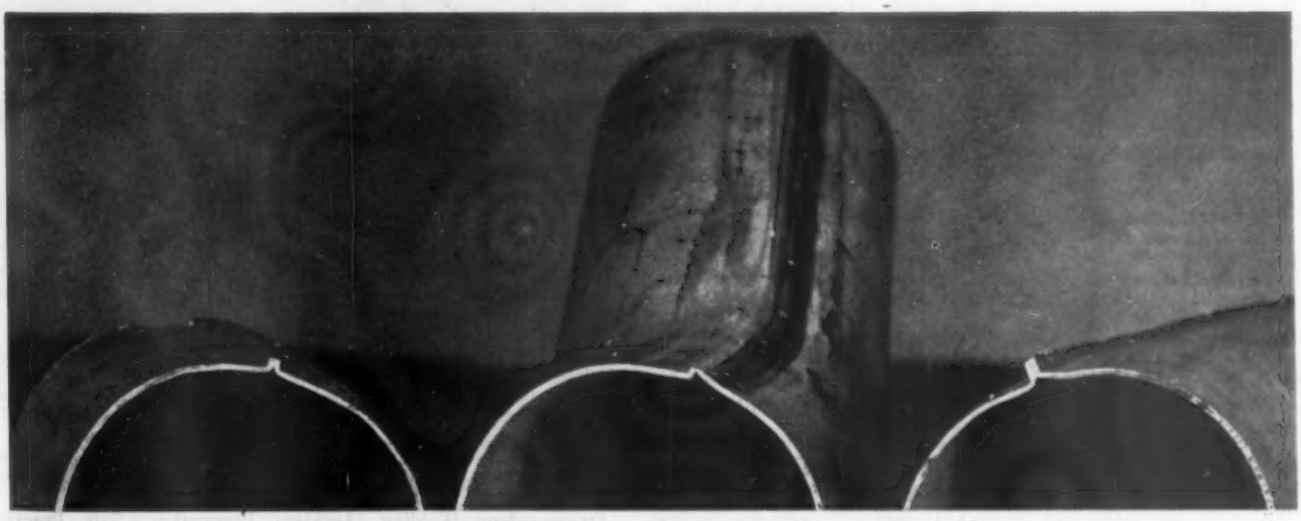

Fig. 9—Three Samples of Spot-Welded Stainless Steel Exhaust Manifold Sections Showing Proper and Improper Alignment of the Half-Stampings for Seam Welding

uses and techniques of the atomic hydrogen welding process, and while literature is available on the essentials, it may be well at this time to mention a word or two about the equipment.

Essentially the process consists of a current supply capable of delivering current of controlled and consistent voltage, after the higher striking voltage is obtained when the arc is struck. Following this the voltage drop is automatically controlled.

A welding head or torch is used which consists of a holder into which the insulated leads enter through the handle. The head of the holder mounts two tungsten wires set at an angle of approximately 50°. The tungsten wires or electrodes can be obtained in various diameters for welding of different gage metals. These electrodes are surrounded with a hollow sleeve through which pure hydrogen is forced under comparatively low pressures usually from one to five pounds. The higher hydrogen pressures are used in tacking while the lower are used for welding.

When the arc is struck between the two tungsten electrodes, the arc is bathed in an atmosphere of burning hydrogen which burns with a yellowish flame while the arc itself can be identified because of its brilliant blue-white color. Goggles similar to those used in arc welding must be used to protect the eyes of the operator.

It is at this juncture that we must truly appreciate the atomic hydrogen welding process, for the action of the electric arc disassociates the hydrogen from its common form of H_2 (molecular) to that of the H_1 or atomic form. This requires a tremendous amount of energy. However, since this energy is absorbed in breaking the hydrogen gas down to its atomic form, it is regained when this gas strikes the metal and an enormous evolution of heat results over a small area. This release of heat energy accounts for the very high temperatures which are obtained. It must also be borne in mind that the atmosphere of hydrogen prevents the oxidation of either the metal being welded or the electrodes, and accounts for the cleanliness of the resultant weld and the comparative long life of the tungsten electrodes. It further precludes the use of flux.

Now that this method has been accepted and is being placed more and more into general use, a word, too, about the training of the operators and welders for the use of this equipment may help prospective users. Both men and women have proved to be quite proficient in the use of the atomic hydrogen welding machines.

The rigid requirements of both the Army and Navy for the certification of these welders have been met very successfully—in fact, with a greater success than the oxyacetylene processes. No particular difficulties have been encountered in their training.

A feature of the torches first used was that they were too heavy. In the majority of cases the aircraft companies engaged in this type of work have constructed smaller and lighter torches to enable women welders to use them without tiring. In some cases a redesign of the torch was necessary to facilitate the welding of closed angle and narrow welds.

Because of the cleanliness of the welds which are obtained by the use of this process and because of the narrow beads and greater speed obtained, it is felt by many that the atomic hydrogen welding method will in the future replace, to a large extent, many of the existing welding processes.

(*Continued from page 307*)

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Flash Welding Alloy-Steel Rings*

By P. B. Scharf†

MANY military devices are fabricated from, or designed around, rings. Due to the necessity for high precision performance and heavy-duty requirements, many alloy-steel rings have been required since the start of the war. These demands brought about a serious shortage in forging capacity for steel rings. Previously, most types of alloy-steel rings had been made by piercing an ingot slab, forging on a mandrel, expanding to the desired size in a series of dies; or by roll working and then splitting into two or more short rings before rough machining and heat treating.

Many items were punched or torch cut from sheet steel, thus wasting large quantities of valuable and critical material. As a result, it was inevitable that more rapid and economical methods of production should be sought. The possibility of applying to alloy steel the flash-welding methods used so extensively and satisfactorily in the production of mild-steel rings, was explored and technique mastered.

As an example of what was accomplished, elliptical inlet flange rings and circular exhaust flange rings for aviation supercharger equipment are shown (Fig. 1). These rings were formerly blanked from plate at an extremely high cost and with a corresponding high loss in scrap material from the blanking. These two rings were formed to the contours illustrated, flash welded and sized, and delivered to the purchaser at a finished price about equal to the raw material costs under the previous blanking methods. Flash welding of another aviation ring (Fig. 2) not only cut material costs, but due to the special section supplied, materially reduced expensive machining.

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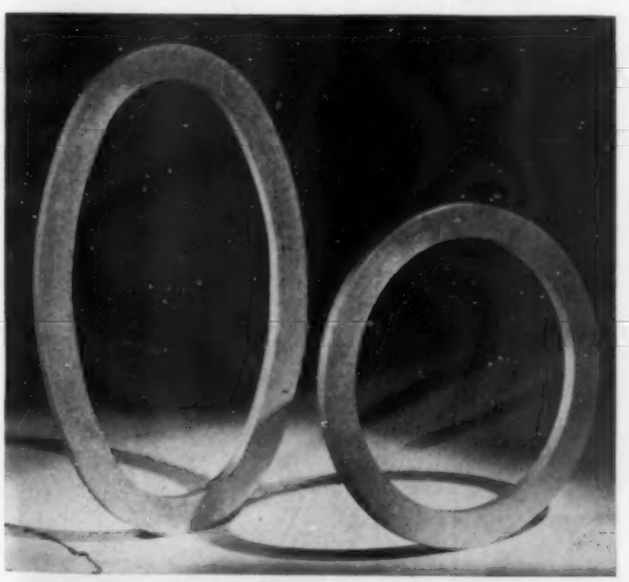


Fig. 1—These Supercharger Flange Rings Were Flash Welded, Sized and Delivered at a Finished Price About Equal to the Raw Material Cost Under the Previous Blanking Methods

Left: Inlet, $8^{1}/_{4}$ in. maj. I.D. x $4^{1}/_{2}$ in. min. I.D. x $^{23}/_{32}$ in. face x $^{9}/_{32}$ in. thick. Right: Exhaust $6^{15}/_{16}$ in. O.D. x $5^{3}/_{32}$ in. I.D. x $^{1}/_{4}$ in. thick.

Fig. 2—By Using a Special Section Subsequent Expensive Machining Was Materially Reduced for the Supercharger Outlet Flange Rings

16 in. O.D. x $11^{13}/_{16}$ in. I.D. x $1^{3}/_{16}$ in. deep, $^{27}/_{64}$ in. average thickness.

But there were many problems involved in adapting peacetime methods to the production of alloy-steel rings for war materiel. Demands were considerably more exacting. Alloy steels, selected for highly specialized characteristics, require closer control of all steps of processing. The behavior of these steels under various procedures had to be observed, and processing steps adapted to the specific characteristics involved.

To assure the desired end results, raw material purchases must be carefully controlled, particularly as to chemical, physical and dimensional properties. Alloy steels are substantially more difficult to process than mild steels. With lower ductility more accuracy and care are required to produce specified form and dimensions. The alloy steels have greater resistance to permanent de-

formation, in this respect being exemplified by spring steel, requiring special methods and tooling to avoid spoilage. Additional steps in fabrication may sometimes be required, since in many cases less work can be done in any one step.

Heat treatment may be required at one or more stages in order to return the material to a proper condition for further working. The presence of high-carbon and alloy elements, necessary for toughness, hardness or strength of the finished product, introduces factors having marked effect on welding characteristics, and calling for a careful adjustment of the welding cycle to produce sound welds.

The manner in which these difficulties have been overcome can be illustrated by considering the manufacture of a roller bearing path ring with an approximate inside diameter of 61 in. and a section $1^{7}/_{8}$ x $1^{1}/_{2}$ in. (Fig. 3). This ring is made from S.A.E. 52100 steel and held to a tolerance on roundness of $^{1}/_{16}$ in. and on flatness of $^{1}/_{32}$ in. In addition, it is essential that in the finished ring the weld and the weld area should have no appreciable difference in properties from those of the nonwelded material.

This steel is a most difficult alloy to process and was formerly considered to be virtually unweldable, due to its exceptionally high carbon content.

Early experiments, however, proved that the alloy could be successfully welded under properly controlled conditions. As can be seen from Table 1, S.A.E. 52100 is a chromium steel of high carbon content, falling within the general classification of stainless steel. Steels containing 1% carbon and chromium of $1^{1}/_{2}$%, by virtue of their hardness and resistance to wear, have become the preference of bearing manufacturers. These steels have, primarily, a deep hardening characteristic, where the actual hardness of the finished product is nearly uniform from surface to center.

TABLE 1

Chemical	SAE 52100 Pct	O. S. 477-Cl.3 Pct
Carbon	0.95 to 1.10	1.00 to 1.10
Manganese	0.20 to 0.50	0.20 to 0.50
Silicon	0.15 to 0.30	0.10 to 0.30
Chromium	1.20 to 1.50	1.20 to 1.50
Phosphorus (max)	0.030	0.030
Sulphur (max)	0.035	0.030
Nickel (max)	.....	0.20

The raw material forms usually used for rolling rings are bars, plates or special sections. In this case, square or rectangular shaped bars are used. As grain structure is of great importance, it is usually desirable to anneal the bars. They are also machine straightened to insure maximum accuracy. Rigid and detailed inspection is essential, as flaws are particularly critical in this material. Brinell hardness tests are made at several points along each bar.

On the bending rolls, preferably of the pyramid type, the bars are rolled to the desired curvature until they conform to gage. Care must be taken to make the resulting rings as true to size and roundness as possible in order to keep subsequent sizing to a minimum. If the ends of the bars are overlapped when roll bending, the ring is trimmed to a calculated inside circumferential length, sufficient excess stock having been allowed for removal of the straight stub portions on each end. If the bars are cut to the exact required length before rolling, a press

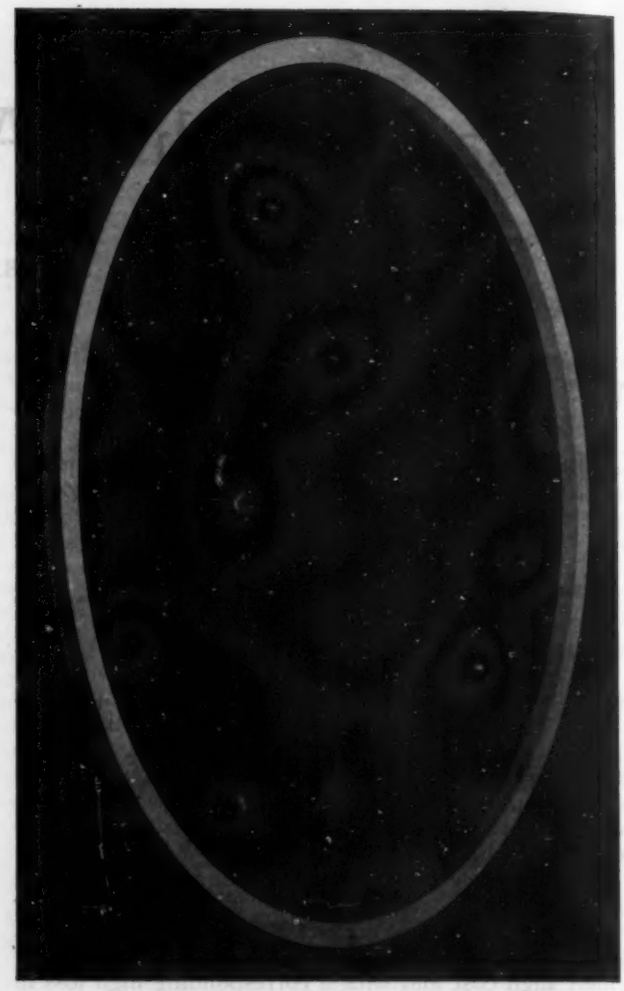


Fig. 3—This Roller Bearing Path Ring of S.A.E. 52100 Steel Has Been Held to a Tolerance of Roundness of $^{1}/_{16}$ In. and the Flatness of $^{1}/_{32}$ In.

This steel is a difficult alloyed process and was formerly considered to be virtually unweldable due to its high carbon content. $64^{11}/_{16}$ in. O.D. x $60^{13}/_{16}$ in I.D. x $1^{1}/_{2}$ in. thick.

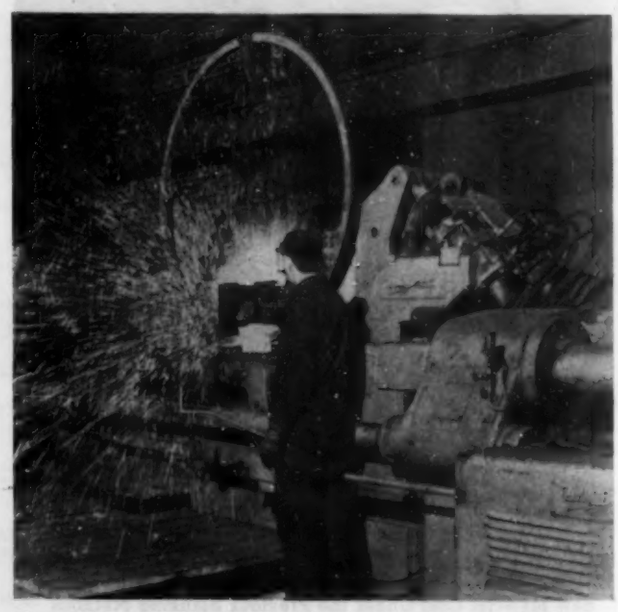


Fig. 4—This Welder Is Used for Sections from 4 to 12 Sq. In. and Rings of 96 to 36 In. in Diameter. Automatic Control of the Operations Is Essential in Order to Obtain Required Precision

is used to "dicker" or shape the straight end portions to conform to the desired curvature of the ring.

The welder shown in Fig. 4 is used for sections of 4 to 12 sq. in. and 96 to 36 in. in diameter. Automatic control of the operation is absolutely essential as the precision required cannot be obtained by procedures introducing the possibility of human variations. Hydraulically operated and electronically controlled welders produced the most suitable results in this type of steel.

The rate of upsetting is of particular importance in welding steel of this type. The time, heat and upset cycle must be carefully controlled as tests made at various speeds of upset have shown that too slow or too rapid upset produces unsound welds.

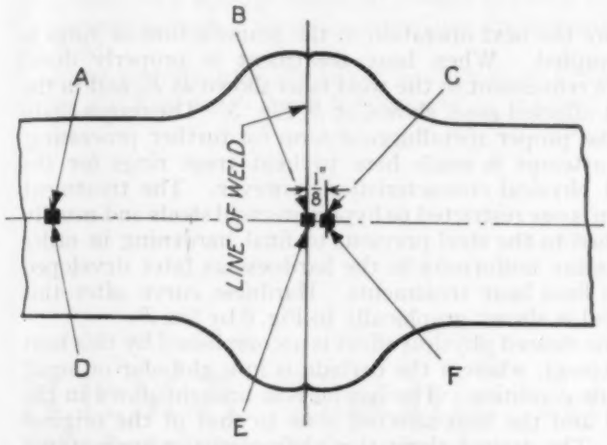
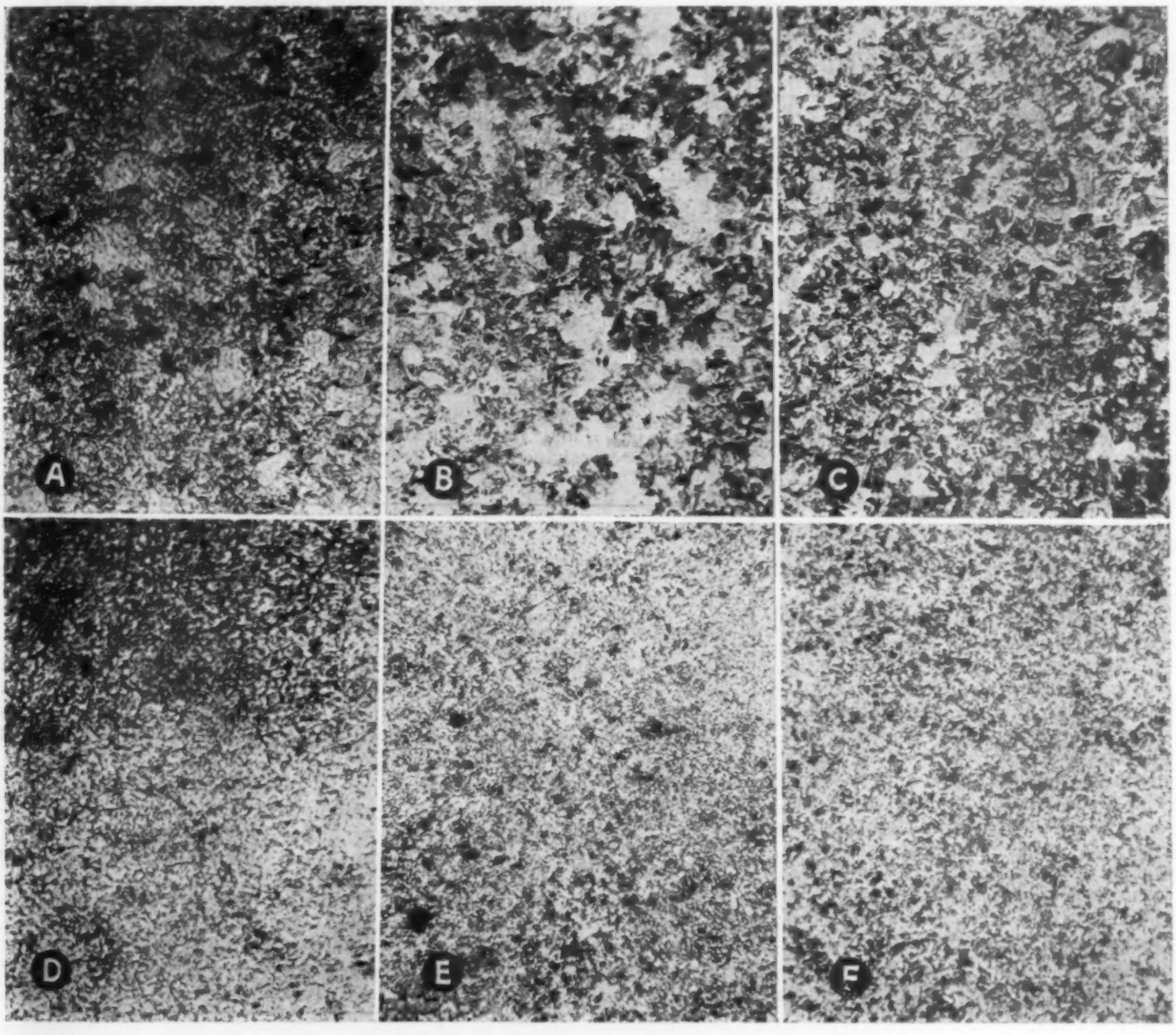


Fig. 5—Micrographs at 100×, Reduced One Third, Were Taken at Positions Indicated

Within the heat-affected zone *B* and *C*, as the temperature during welding was above the critical, the crystals are large and the area is very hard and extremely brittle. After proper heat treatment, grain refining in the weld is shown at *E*, and in the heat-affected zone at *F*.



Metallurgical examination of the welded ring may be reviewed by referring to Fig. 5. These micrographs were taken at 100 diameters, etched in nital, at the positions indicated. Spheroidized structure is shown at *A* in the unaffected area. *B* in the view is directly in the line of the weld, and *C* is in the immediate heat-affected zone, as-welded. It is clearly indicated that in the ring, outside the heat-affected zone, good machinability and workability exist. Within the heat-affected zone, however, the temperature during welding was above the critical, with the result that the crystals are large, the area being very hard and extremely brittle.

Hypereutectoid steels such as S.A.E. 52100 have been observed having a maximum hardness of 600 Brinell

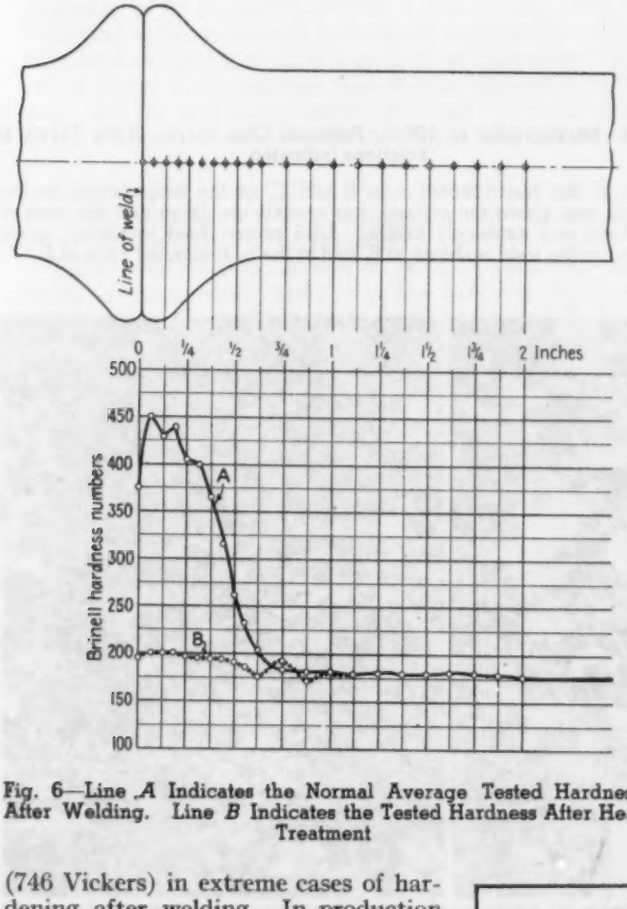


Fig. 6—Line *A* Indicates the Normal Average Tested Hardness After Welding. Line *B* Indicates the Tested Hardness After Heat Treatment

(746 Vickers) in extreme cases of hardening after welding. In production on these rings the normal average tested hardness is shown graphically by line *A* in Fig. 6.

Under the circumstances it is necessary at this point to introduce heat treatment to condition the weld area for further processing. As rapidly as the rings are welded and disengaged from the welder dies, chippers and grinders are used to remove all excess material due to upset and flashing. This operation is completed while the weld is still hot and the material is relatively soft. The heat treatment usually accorded to the ring is either a localized annealing or a full anneal of the entire ring. The latter has been the most effective method in shop practice.

A temperature recording chart is made of each furnace run and inspected

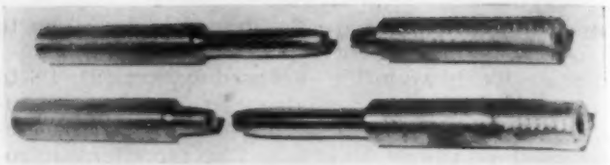


Fig. 7—The Breaks in the As-Welded and the "Annealed" Bare Are Characteristically Cup-Shaped. Above, As-Annealed. Below, As-Welded

before the next operation in the manufacture of rings is attempted. When heat treatment is properly done, grain refinement in the weld is as shown at *E*, and in the heat-affected zone, shown at *F*, Fig. 5. The ring is again in the proper metallurgical form for further processing. No attempt is made here to heat treat rings for the final physical characteristics, however. The treatment given is one restricted to hypereutectoid steels and usually applied to the steel previous to final hardening in order to assure uniformity in the hardness as later developed from final heat treatments. Hardness curve after this anneal is shown graphically in Fig. 6 by line *B*.

The desired physical effect is accomplished by this heat treatment, wherein the carbide is in a globular or small nodule condition. The hardness is brought down in the weld and the heat-affected zone to that of the original bar. The desired elongation characteristics are restored and brittleness is thereby removed.

The sizing operation is the next step in the line of production. One of several methods may be used. The ring may be expanded circumferentially on a tapered plug in a hydraulic press, tire-set or shrunk, or uniformly expanded on an expanding machine. The latter method was used on the rings under consideration. Special dies were used to insure that the rings, when expanded, would be round and substantially flat. Inspection gages and face plates are used to check the completed ring. Rings are checked for inside diameter, circumferential length inside, flatness and sectional dimensions.

Specimen bars of S.A.E. 52100 steel before and after flash welding were turned to $^1/_2$ in. diameter and tensile tested. In the welded specimen, the weld was in the middle portion of the turned specimen. In all cases of properly heat-treated bars, tensile fracture of the welded specimen occurred in the parent metal at a distance well removed from the weld. The breaks in the "as-welded" and the "annealed" bars were characteristically cup shaped, as illustrated in Fig. 7. The average tensile

TABLE II

Physical Properties of Welded SAE 52100 Steel

Specimen No.	Yield Strength, Psi	Ultimate Strength, Psi	Elongation in 2 In.	Reduction in Area, Pct	Brinell Hardness of Bar	Remarks
1	112,000	224,000	19	30	285	Parent metal bar heat treated to 285 Bhn, broke approximately in the middle of the machined length, cup break.
2	65,000	120,000	16	31	285	"As-welded" bar broke in weld, cup break, inadequate heat treatment.
3	62,000	109,000	18	39	285	Welded and heat treated to 285 Bhn, broke in weld, inadequate heat treatment.
4	68,500	120,500	23	48	175	Parent metal bar heat treated to 175 Bhn, broke approximately in the middle of machined length, cup break.
5	63,800	94,800	23	47	175	"As-welded" bar broke outside of weld, cup break. Fig. 8.
6	64,900	98,000	22	43	175	Welded and heat treated to 175 Bhn, broke outside of weld, cup break, correct heat treatment indicated. Fig. 8.

strength and other physical characteristics are shown in Table 2, specimens 4, 5 and 6. Specimens 1, 2 and 3 are tabulated for comparison and their interpretation shows how critical the proper heat treatment is to the success of this process.

In the process as described the welding stresses in the resulting ring are at an irreducible minimum. The residual stresses in the ring after expanding are at a minimum and very equally displaced around the ring form. Symmetrical stresses alone do not reduce the strength of the weld.

In the manufacture of finished bearing races or roller paths, the final finish given the surfaces on the steel has a greater influence on its fatigue strength than any characteristic attributable to the weld.

Flash welding of alloy steels is not only practical but advantageous. Results are uniformly more accurate than those resulting from previous methods, the amount of necessary subsequent machining being greatly reduced and even eliminated in many instances. The savings in scrap materials are appreciable, a point of particular importance in the case of high-cost alloys. Most rings can be made cold, thus eliminating cost of furnace heating. Tool and die maintenance is generally less than with other processes. Production line operation is facilitated.

N.E.M.A. Electric Arc-Welding Machine and Electrode Standards

A COMPLETE set of new standards for electric arc-welding machines and electrodes, Publication No. 45-105, September 1945, has been released by the National Electrical Manufacturers' Association.

The Electric Welding Section of N.E.M.A. initiated welder standards in October 1936 and has revised them from time to time to conform to the requirements of the rapidly growing arc-welding art. This latest revision of the Standards developed by the Electric Welding Section through consultation among manufacturers, users, power companies and national engineering societies incorporates the desirable changes resulting from wartime experience and covers a most important postwar requirement—a.-c. welders for the farm and small community repair shops.

The welding standards completely cover d.-c. welders of both variable-voltage and constant-potential types, including circuit control equipment for the latter. Also included are two types of a.-c., transformer-type arc welders, designated as the industrial type, single-operator and the limited-input type.

The new standards coordinate and simplify the method of rating welders without basically changing the size of the welder. For example, the d.-c. 300-amp. welder with a specified maximum and minimum output as covered by the revised standards does not basically differ in actual welding capacity from a d.-c. 300-amp. welder meeting the requirements of the superseded standards.

Heretofore, d.-c. welders were rated on a short-time basis, and a.-c. welders (except large machines used in automatic welding) were rated on a duty-cycle basis, each with a maximum and minimum welding current. The duty cycles serving as a basis for rating the a.-c. welders were slightly lower than the duty cycle corresponding to the short-time, 1-hr. and $^1/_2$-hr. ratings of the d.-c. welders. The new standard, using the d.-c. welders as a base, rates both d.-c. and a.-c. welders on the basis of the same duty cycles. In addition to the above a definite duty cycle has been assigned to the maximum output.

Since all arc welding imposes a duty-cycle load, the desirability of using a duty-cycle method of rating is apparent. The standard defines duty cycle as the ratio of arc time to total time. For the purposes of rating and testing, the time period of a complete test cycle is 10 min. For example, in the case of a 60% duty cycle, load is applied under specified conditions for 6 min. and is off for 4 min. In testing, this cycle is repeated until constant temperature is reached, or for a maximum of 4 hr.

Table 1—Ratings for Variable-Voltage Direct-Current Welders

EW4-14 Current, Voltage and Duty-Cycle Rating.—Variable-voltage arc welders shall have the ampere ratings shown in Column 1, at rated load voltages shown in Column 2, and with per cent duty cycles shown in Column 3.

Rating			Welding Current Range		
1	2	3	4	5*	6*
Amperes	Load Volts	Duty Cycle, %	Minimum Amp. at 20 Load Volts	Maximum Amp. at Rated Load Volts	Duty Cycle, % at Maximum Amp. and Rated Load Volts
150	30	50	20	185	30
200	30	50	30	250	30
200	40	60	40	250	35
300	40	60	60	375	35
400	40	60	80	500	35
600	40	60	120	750	35

* Welders may be operated at the specified maximum current and duty cycle at maximum current at rated load volts with approximately the same temperature rises as those specified for the rated amperes and duty cycle (Columns 1 and 3).

NOTE I: Load voltage is the voltage between the welding terminals of the welder when current is flowing. See EW50-92.

NOTE II: In arc welding, duty cycle shall be defined as the ratio of arc time to total time. For the purpose of this standard the time period of one complete test cycle shall be 10 min. For example, in the case of a 60% duty cycle, load shall be applied continuously for 6 min. and shall be off for 4 min. Load shall not be applied for more than 6 min. out of any 10-min. period.

Industrial-Type Welders

Tables 1 and 2 show the new standard ratings and duty cycles for industrial-type welders. Referring to the tables, welders corresponding to the old 1-hr.-rated d.-c. and 50% duty-cycle a.-c. welders are now rated on the basis of a 60% duty cycle and must be capable of delivering a maximum welding output of 125% rated load at a 35% duty cycle. The smaller sizes, 200 amp. and below,

Table 2—Ratings for Industrial-Type Single-Operator Transformer Arc Welders

EW5-14 Current, Voltage and Duty-Cycle Rating.—Transformer-type arc welders shall have the ampere ratings shown in Column 1, at rated load voltages shown in Column 2, and with per cent duty cycles shown in Column 3.

Rating			Welding Current Range			
1	2	3	4		5*	6*
			Minimum Amp. and Load Volts			
Amperes	Load Volts	Duty Cycle, %	Amp. at Load Volts		Maximum Amp. at Rated Load Volts	Duty Cycle, % at Maximum Amp. and Rated Load Volts
150	30	50	20	20	185	30
200	30	50	30	20	250	30
200	40	60	40	20	250	35
300	40	60	60	20	375	35
400	40	60	80	20	500	35
500	40	60	100	20	625	35
750	40	1 hr.†	187	30	935	
1000	40	1 hr.†	250	30	1250	

* Welders may be operated at the specified maximum current and duty cycle at maximum current at rated load volts with approximately the same temperature rises as those specified for the rated amperes and duty cycle (Columns 1 and 3).

† These sizes are rated for service with automatic machine welders. In testing to determine the rating, temperature, rise and other characteristics, rated current at rated load voltage shall be applied for 1 hr. immediately followed by the application of 75% rated current at rated load voltage for 3 hr. The temperature rise shall be measured at the end of the 1-hr. period and at the completion of the 3-hr. period at 75% rated current and load voltage.

NOTE I: Load voltage is the voltage between the welding terminals of the welder when current is flowing. See EW50-92.

NOTE II: In arc welding, duty cycle shall be defined as the ratio of arc time to total time. For the purpose of this standard, the time period of one complete test cycle shall be 10 min. For example, in the case of a 60% duty cycle, load shall be applied continuously for 6 min. and shall be off for 4 min. Load shall not be applied for more than 6 min. out of any 10-min. period.

previously rated 30-min., 30-v. d.-c. and 40% duty-cycle a.-c., are now rated on the basis of a 50% duty cycle and must be capable of delivering a maximum output of 125% rated load at a 30% duty cycle.

Table 3—Limited-Input Type, Transformer Arc Welders

(Tabulated Characteristics Extracted from Standards)

There shall be two ratings—130 and 180 amp. Details follow:

1.	Rated load amperes (maximum obtainable at rated load voltage)	130 180
2.	Rated load voltage, v	25 25
3.	Minimum welding current, amp	20 20
4.	Duty cycle at rated amperes, %	20 20
5.	Maximum open circuit (no-load voltage) at any current setting	65 65
6.	Primary volts	230 230
7.	Amperes input at rated load when built without power-factor correction shall not exceed	33 46
8.	Amperes input at rated load when built with power-factor correction shall not exceed	27 37
9.	Short-circuit current—maximum allowable ratio of short-circuit current to rated current at rated load volts, %	150 150
10.	The input current at any reduced output current setting shall not exceed the rated input current	
11.	The no-load input current of a power-factor-corrected welder shall not exceed 50% of its rated input current	

NOTE I: The same methods of test and temperature rise provided in N.E.M.A. Standards for Industrial-Type Welders apply.

NOTE II: These welders shall be supplied with primary connection accessories consisting of not less than 6 ft. of three-conductor primary cable, one conductor of which will serve to ground the case, cores or other noncurrent-carrying parts and a three-prong polarized plug and matching receptacle.

Limited-Input Type, Transformer Arc Welders

A new standard for transformer arc welders below 200 amp. is introduced for the first time. These welders are designated as limited-input type, transformer arc welders. This new standard is developed to apply to welders served by single-phase power lines of limited capacity supplying farm or small communities.

These welders are rated (see Table 3) on the basis of maximum output at 20% duty cycle at a load voltage which gives satisfactory welding as it is believed that these welders will not be subject to the severe duty encountered in industry. A maximum input is assigned which must not be exceeded in meeting the maximum output. The input is limited so that power companies serving the welders may know what to expect as maximum line load conditions.

Test procedure for temperature, efficiency and dielectric tests has been revised and brought up to date to correspond to latest American Standards.

The electrode standards have been revised and published in two parts. The part covering classifications, standard diameters and package weights is included in the present publication. The new standard for color markings for electrode identification is published as a separate standard, Publication No. 45-108.

Complete definitions covering terms referred to in the standards, such as duty and service classifications, ratings, welds and welding, complete apparatus and parts, etc., are included in the Standard.

The new standard represents an important contribution in promoting economies and assisting users in the proper selection of arc-welding machines. Copies may be obtained from the National Electrical Manufacturers' Association, 155 E. 44th St., New York 17, N. Y.

Welding a 500 Hp. Diesel Engine*

By Leo Berner†

ELECTRIC-ARC welding is outstanding in the long list of manufacturing processes that have received a strong impetus toward enlargement, improvement and general recognition as a result of the terrific war demand for weldments. It is a well-known fact that the recent war could not have been won without the large construction program for welded ships. The ships had to be designed for welding to be produced so fast and in such vast quantities, since it takes much longer to construct a riveted ship. The use of welding, in proportions and applications unknown before the war, has helped tremendously in winning the critical battles of Britain with its supply problem and the resulting battle of the Atlantic calling for a steadily mounting number of welded ships, such as freighters, escort ships and subchasers.

The average man usually thinks of a welded hull only and overlooks all the other items that make up a ship. Among these other items much more welding will be found, such as deck equipment, mooring bitts, cleats, anchor-hoist machinery, masts and cargo hoists, rudders, stearing equipment, anchors, boilers, condensers, welded piping, tanks, bases and foundations, railings, platforms, stairways, gun mounts, gun shields, guns. There is no end to this list, since there is hardly a piece of equipment on a ship that today has not some welding on it in order to produce it cheaper and faster.

* Presented at the January 28th Meeting, San Francisco Section, A.W.S.
† Manager and Chief Engineer, Leo Berner Engineering Co., San José, Calif., formerly Welding Engineer, Joshua Hendy Iron Works, Sunnyvale, Calif. Chairman, A.W.S., San Francisco Section.

Ships, especially the smaller ones, such as invasion barges of many different types and description, which are Diesel powered, usually have welded Diesel engines. A hit or even a near miss by an enemy bomb or shell will not damage the engine if it is of the welded type, whereas a cast-iron engine will often fail due to a cracked base or block, resulting from the shock of a shell exploding yards away from the ship. The shock of an explosion is carried through the water into the hull of the ship and then through the foundation of the engine into the engine itself, where it is able to shatter any part made of cast iron.

There are advantages other than this shatter-proof feature which, however, also protects against peacetime accidental damage, such as falling objects, etc., favoring a welded engine against a cast-iron engine.

One of these advantages is the lighter weight of the welded engine, which is of considerable importance on ships of any description where every pound saved in the weight of the engine can be added to the freight or pay load of the ship.

Steel has a much higher rigidity than cast iron. The modulus of elasticity of steel is 30,000,000; that of cast iron only 12,000,000. Therefore, at the same stress per square inch, same section and area, when a steel bar deflects only 0.004 in., a cast-iron bar would deflect 0.010 in., or $2^1/_2$ times farther.

In actual stress calculations, the above would reflect itself in the fact that steel can be loaded in direct compression to $2^1/_2$ times the stress of cast iron, with identical

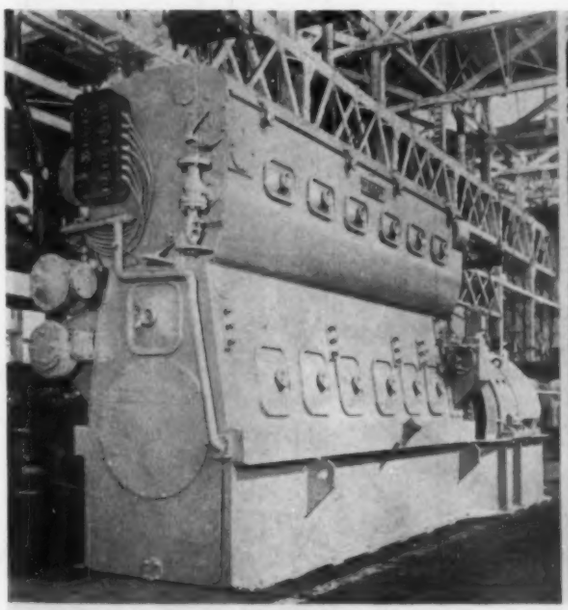


Fig. 1—Front View of the Hendy Series "50" Diesel-Generator, D. C., 250 Kw., as Built for U. S. Maritime Commission

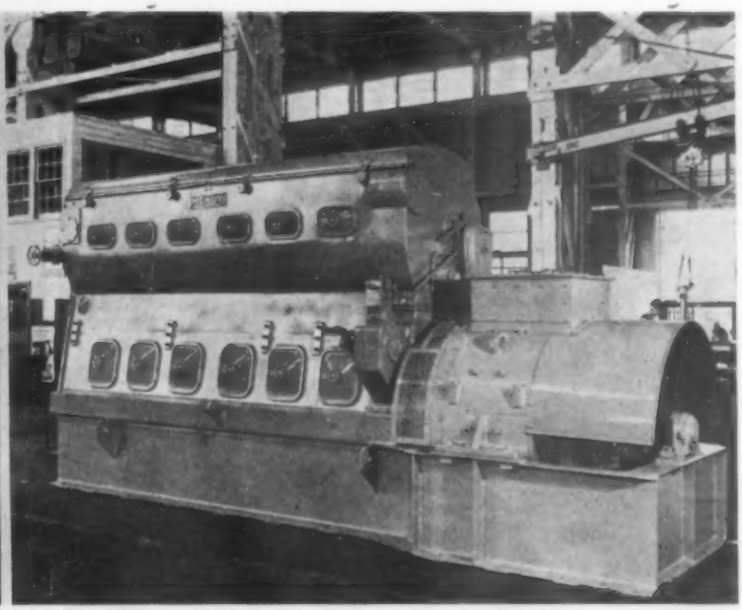


Fig. 2—Generator End of Hendy Series "50" Diesel-Generator, D. C., 250 Kw., as Built for U. S. Maritime Commission

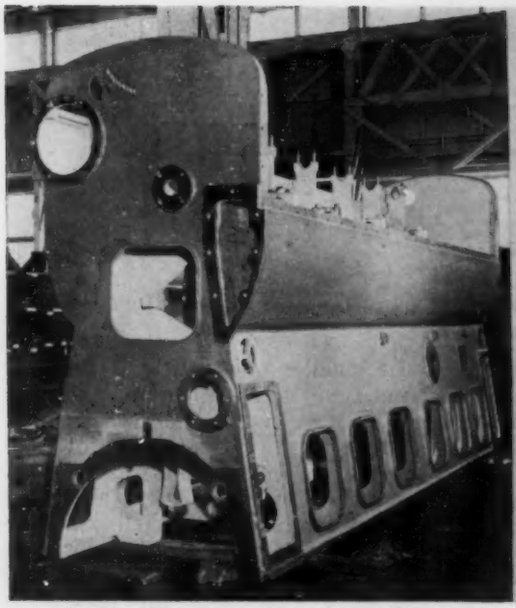


Fig. 3—Finish-Machined Engine Block

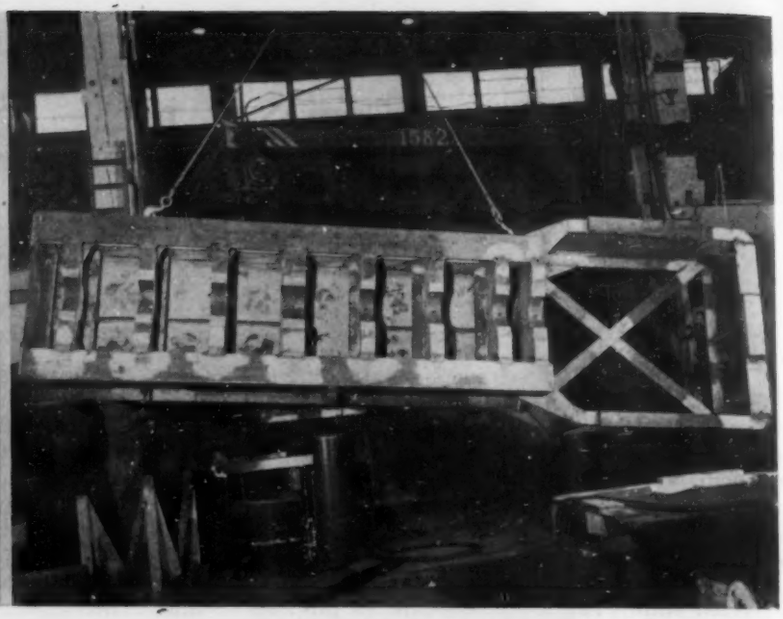


Fig. 4—Finished Welded Base

deflection or rigidity. For bending stresses, the comparative moment of inertia of cast iron is taken as only 40% of that of steel. Moment of inertia depends on geometry, independent of the material. The stress allowed on that section is chosen by the designer for the material considered. Likewise allowable stresses for steel are chosen with respect to yield strength and those for C. I. with respect to modulus of rupture. In this case a true comparison must entertain section (weight and geometry), deflection and stress (with respect to allowable).

Another very important advantage is the fact that steel has a higher fatigue-resisting endurance limit, permitting a much higher number of load cycles before failure than cast iron.

There have been many arguments with respect to the cost of a welded structure versus an iron casting, and it is doubtful whether this argument will ever be satisfactorily settled. It is therefore best to say that such a cost comparison depends entirely upon the individual design, and whether the cost-reducing features of welding have been fully applied and whether proper methods and facilities for low-cost production have been worked out.

Our experience shows that with quantity production permitting use of jigs and tools, good welding design, and the best production methods, a weldment will equal or be slightly below the cost of an iron casting, if pattern, pattern repair and pattern storage costs are considered. This is especially true if rough-casting scrappage and, usually overlooked, costly semifinished casting scrappage or salvage is considered in the cost comparison.

Often overlooked is the advantage that changes in design can be made much quicker and cheaper on a welded engine.

There is a further advantage in the difference in factory space for the storage of raw material for engine production. The storage of plates and shapes required for the

Fig. 5—View of Diesel Welding Department

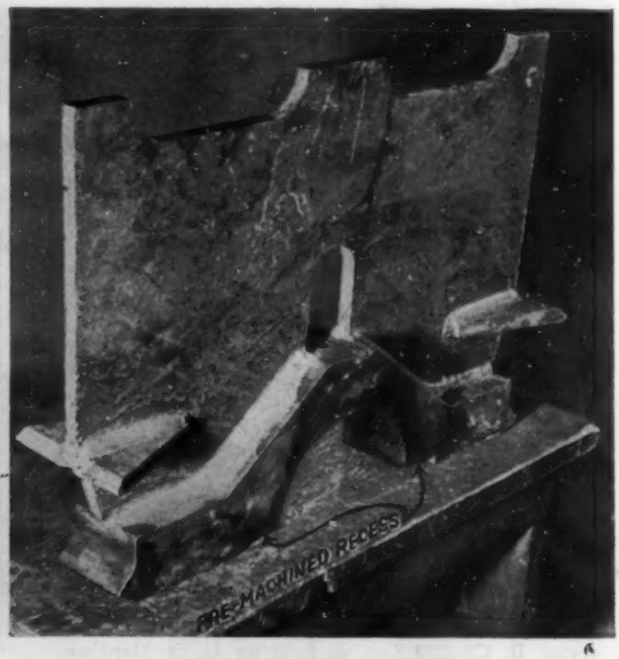


Fig. 6—Bearing Support Showing Detail

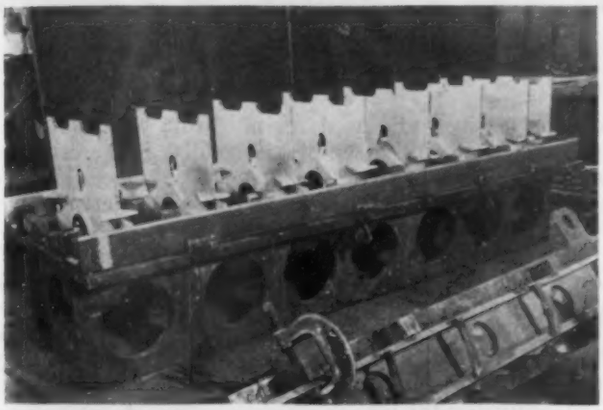
welded engines use less space than the castings of a cast engine.

The cleaner surfaces of rolled plates and shapes require less cleaning time, "smooth on," or other fillers for a smooth paint job.

Predictability of weight and strength is much better on weldments than on castings. The expected weight of a weldment can be estimated much closer, whereas the casting thicknesses are always subject to excessive wrapping in the mold, resulting in an unpredictable thickness and weight.

With regard to strength, castings are again more unpredictable, considering the frequent occurrence of blowholes, shrinkage holes, cracks and porosity; while steel plates and shapes are well known to be free of such faults. The welds, if ordinary care is taken, are also free from holes or cracks.

Fig. 7—Bearing-Support Assembly on Jig



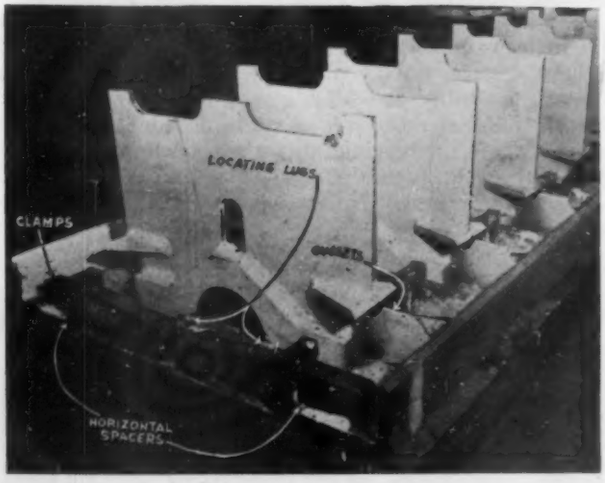


Fig. 8—Closeup, Bearing-Support Assembly Showing Detail

The Navy, for reasons of shatter-proof construction, requires small ship propulsion Diesels and Diesel-generator sets made of steel. Cast steel engines are definitely more expensive and entirely too slow in delivery; hence a welded Diesel engine, in answer to urgent war demands, has been designed and is being manufactured by Joshua Hendy Iron Works in Sunnyvale, Calif.

The "Hendy" Diesel is all-welded, since the 6- or 8-cylinder engine block, the base and generator mounting, the exhaust manifold, the piping, control linkages, hoods, covers, platforms and guards are all of welded construction, as illustrated in Figs. 1 and 2.

The "50" Series, Model 56E Diesel engine is of the stationary type, direct-connected to a 250-kw. generator,

Fig. 9—Bottom Assembly on Base, Interior View

the complete unit being mounted on a common base. The engine has 6 cylinders, 12-in. diameter, with a 15-in. stroke and is rated 500 hp. at 500 rpm. It is equipped with solid, open chamber or direct unit injection and is fully pressure lubricated.

From a welding point of view, the most important parts are, naturally, the engine block and base (Figs. 3 and 4), which will be described in more detail later.

Generally, all of the welding in the construction of these parts is by the electric-arc process, using flux-covered rods of about equal amount of $^{3}/_{16}$- and $^{1}/_{4}$-in. diameters and of A.W.S., E6020 quality. All welds, wherever possible, are positioned for flat down-hand welding in special jigs or setups for increased speed, better appearance and increased strength of the weld with corresponding lower cost.

Both the block and the base have been designed for a minimum amount of welding. Where possible, parts are flanged or formed, this being cheaper and of better appearance than welding. (See the flanged access openings in the engine block, Fig. 5.)

All welds subject to fatigue stresses are grooved joints, welded from one side, chipped from the other side, and then welded and ground perfectly flush on both sides to insure 100% effective joints, free of any notch effect or stress concentration, pinholes and inclusions, and subject to Magnaflux and X-ray inspection. Such 100% effective welded joints are of great importance in an internal-combustion engine, where fatigue stresses of a pulsating or reversing nature are combined with an explosion impact and where the stress cycles are exceedingly high, amounting to 865,000 cycles per day, or 25,920,000 per month, on a 600-rpm. engine. We are dealing here with indefinitely repeated cycles, a subject requiring special study for which there is no room here to explain fully.

However, the stresses in such joints must be kept very low considering fatigue failure. Stress analysis must be considered very carefully to insure against failure, even after years of service. It has always been good practice to base calculations on the maximum stress, rather than on the average, but on welded structures it is imperative that maximum stresses only be considered, because they

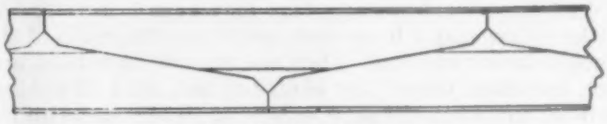


Fig. 10—Nesting of T-Sections

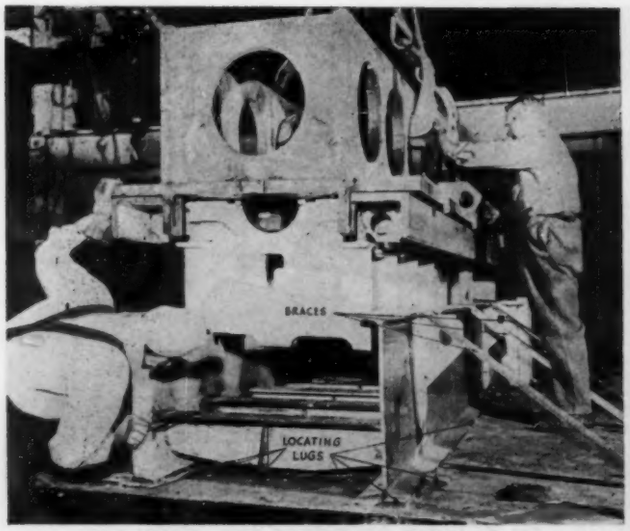


Fig. 11—Bearing Support Assembly Being Lowered into Bottom Assembly. (Note That Jig Is Still in Place)

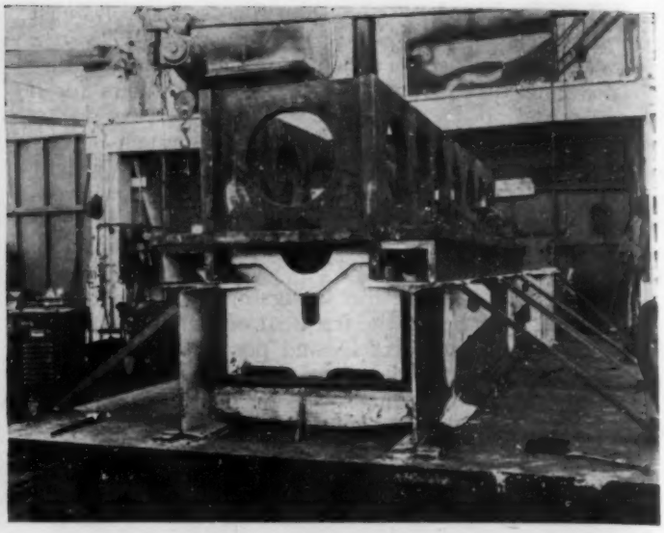


Fig. 12—Bearing-Support Assembly in Place in Bottom Assembly

alone govern the life of a weld under fatigue load conditions. It is also well known that under fatigue load conditions, stress concentrations, caused by undercuts, pinholes, inclusions, notches, sharp corners, so constantly encountered in welding, can raise the designed maximum stress to an actual stress which is 3, 6 or even 8 times higher.

In connection with such fatigue loads, one cannot overemphasize the importance of eliminating the easily recognized stress-raisers in the design of a welded joint and the small hard-to-see or hidden stress raisers in the weld, as described above.

Residual, locked-up or internal welding stresses, whatever you wish to call them, need no consideration here, as our structures are all stress annealed to reduce these stresses to a value below any influence of a dangerous nature.

The engine base (Fig. 4) is made up from three sub assemblies:

(*a*) *The Bearing Support* (*Fig. 6*).—This part, originally a casting, is now welded, eliminating excessive salvage cost for chipping out and welding continuing reoccurring shrinkage pockets in way of the stud-hole bosses and to step up production, which was held back by a slow supply of castings from overloaded foundries. It should be noted that the bearing block itself is designed to be burned from a nesting for a minimum amount of wastage. The bearing block is drilled for lubrication after burning, but before welding. The six pieces forming this assembly are brought together and welded in a jig.

This jig locates all parts and holds them in place for tacking and welding, thus reducing setup time to a minimum, permitting also flat down-hand welding of all joints.

(*b*) *The Bearing Support Assembly* (*Fig. 7*).—This assembly is started by the lengthwise angles, forming the top of the base. They are positioned upside down on the strongback jig and are held securely by means of lugs, wedges and quick-acting special clamps (Fig. 8). The clamps deserve special attention as it is by such time-saving methods that the fabricating cost can be held low.

The horizontal spacers (Fig. 8) take a heavy load in order to prevent a horizontal shrinkage distortion of the angles during welding. They are difficult to remove and are, therefore, burned out along one side after all welding is done and when the jig is removed. The spacers on the other side are then no longer under a strain and can be removed easily to be used again. From the above, it is apparent that this assembly is welded in a restrained condition and very little shrinkage takes place. The resulting high internal residual stress is later removed during stress annealing.

The eight bearing supports are next mounted upside down and tacked to the angles. They are accurately spaced on the jig by locating lugs for the proper center distances and for accurate lengthwise line-up. To obtain this correct line-up, the bearing supports are premachined at the bearing split recesses, which engage the machined locating lugs on the jig.

The bearing supports are now completely welded to the angles from the accessible side. The inaccessible side facing the strongback cannot be welded until the bearing support assembly has been combined and welded with the bottom assembly. This is done to eliminate the necessity of again clamping the bearing-support assembly for welding in a reversed position to reduce welding heat distortions. After welding to the bottom as-

Fig. 13—Welding After Removal of Bearing-Assembly Jig

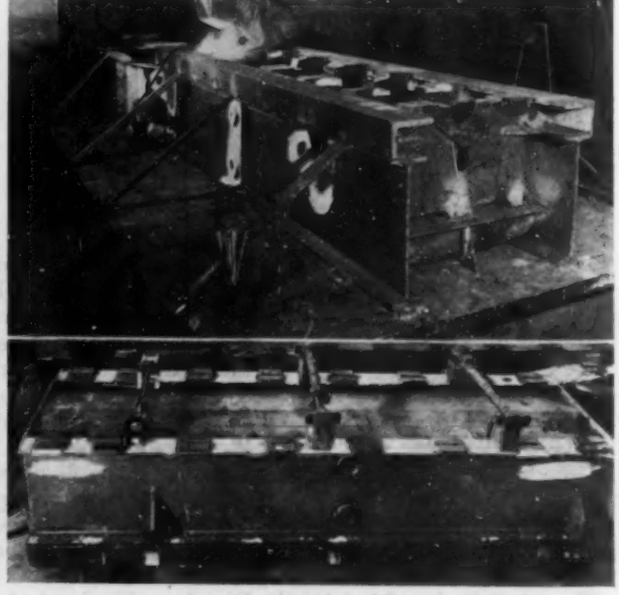


Fig. 14—Bottom View of Finish-Welded Base with Screw Jacks in Place

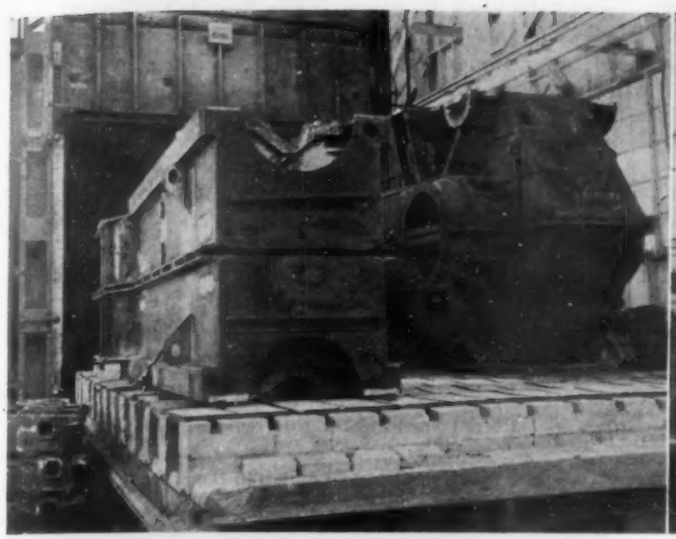


Fig. 15—Two Bases and Two C-3 Turbine Reduction-Gear Case Covers Ready for Annealing Oven

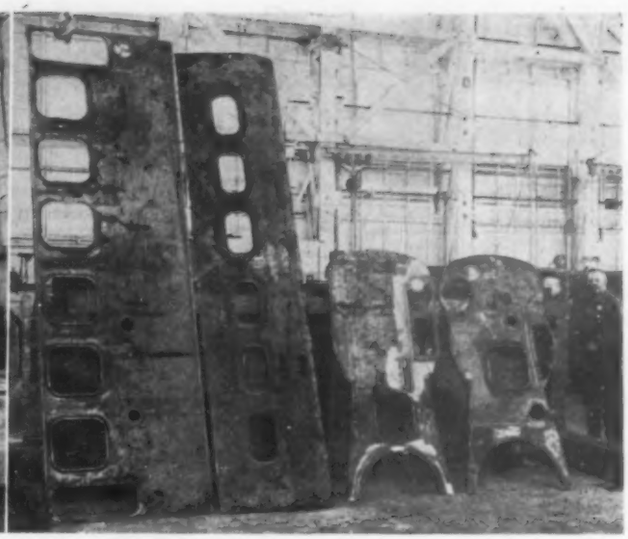


Fig. 16—Various Subassemblies of Diesel Block

sembly, the complete assembly is strong enough to resist distortions.

The small gussets located in the same plane as the web of the bearing support are welded to the support and angle while the assembly is still in the jig. This gusset was purposely not made a part of the bearing support in order to simplify the setup. Being loose, it can quickly be fitted to the bearing support and between the angle and the top flange of the beam, in a distance that is subject to variations, caused by mill tolerances on the depth of beam, thickness of flange of the beam and thickness of the leg of the angle.

(*c*) *The Bottom Assembly* (*Fig. 9*).—This assembly is set up right side up and is started by placing the preformed main beam against locating stops and securely tack-welding them to the strongback jig. The beams usually require some straightening, which is done during and after the setup tacking. The straightened beams are braced securely on the outside to the extreme edges of the strongback, being especially wide for this purpose.

Fig. 17—Bulkhead Assembly of Block

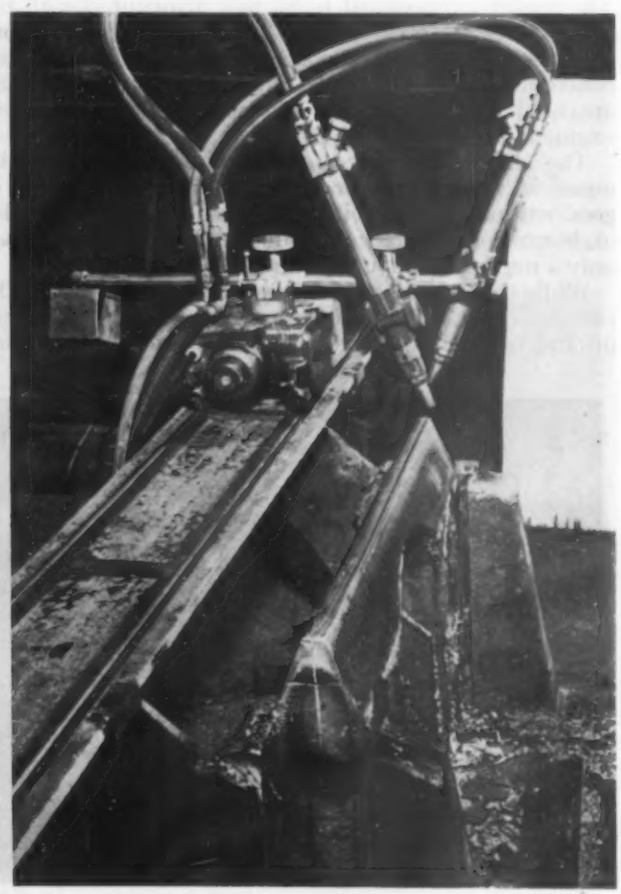


Fig. 18—Torch Beveling Lower Bulkhead Plate

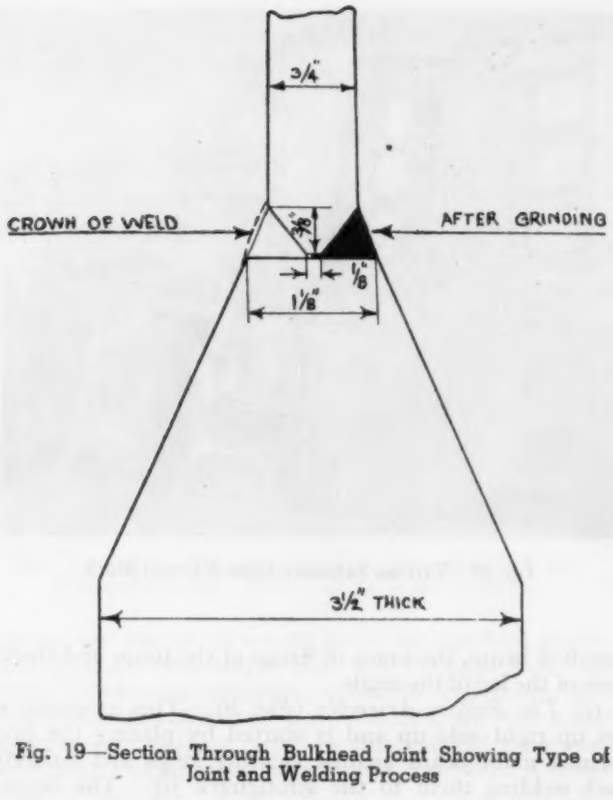


Fig. 19—Section Through Bulkhead Joint Showing Type of Joint and Welding Process

The eight transverse T-sections are now placed on the locating lugs on the jig and tacked to the main beam. No measuring or aligning of any kind is required, since the locating lugs perform these functions automatically. The reader is presumed to be well acquainted with the time-saving features of such locating lugs on jigs, but we wish to stress these points since they are the main contributing factors for fast and cheap fabrication, and are used extensively and successfully on these Diesel engine weldments.

The shape of transverse T-sections deserves special mention because it represents a perfect illustration of good welding design, being nested and burned from a 14-in. beam so that each cut produces two pieces and causes only a negligible amount of scrap (Fig. 10).

While the T-sections are being tacked and welded, the two end bulkheads in the generator base sections are set up and tacked into place. The bulkhead at the engine end of the base, however, is not installed at this time to keep the base open for the later insertion of the oil pan. All other minor parts—such as the channel bracing in the generator sections, stiffeners, lifting lugs, generator bolting pads, etc.—are tacked and welded as the work progresses.

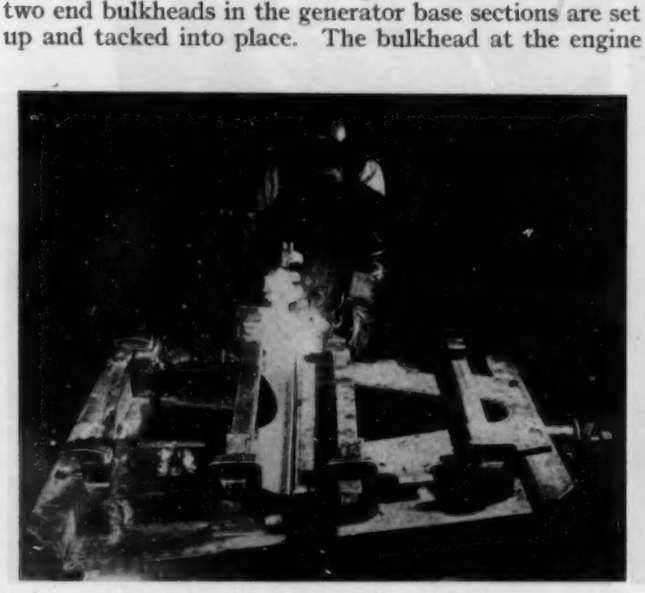
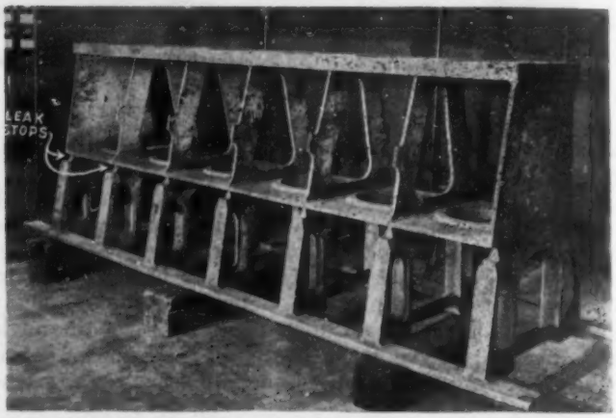


Fig. 20—Bulkhead Welding Jig

As soon as all accessible down-hand welds on the inside of the engine end of the base are completed, the finished bearing-support assembly and jig (Figs. 11 and 12) are inserted right side up, into the bottom assembly, to be tacked and welded at all accessible down-hand joints. After this welding is done, the jig of the bearing assembly is removed, making the top of the base accessible for down-hand welding (Fig. 13).

The final base assembly is now chipped loose from the bottom strongback, placed upside down, sideways and into 45° tilted positions for down-hand positioned welding of all remaining joints. While in the upside-down position, the base is accessible for the installation and welding of the oil baffles, filler pipes, bolting pads, etc. In this position and after all parts are completely welded, the oil pan is inserted from the open end, which is then closed up by the end plate.

Fig. 21—Completed First Step in Block Assembly



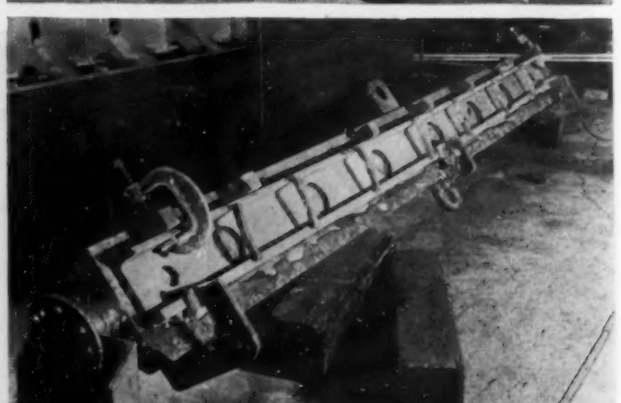


Fig. 22—Exhaust-Manifold Support Assembly

To facilitate insertion of the light, easily deformed oil pan and to speed up the wedging of it against the transverse T-sections, the flanges of the main I-beams are forced apart by heavy jacks. These jacks are kept in place until the pan is completely welded to beams and T-sections to prevent shrinkage distortion of the beam welds during welding of the pan (Fig. 14).

It may be of interest to explain the method used to locate the many bolting pads at the bottom flange of the base. The location of these pads is scribed into the top of the bottom assembly jig, and before removing the

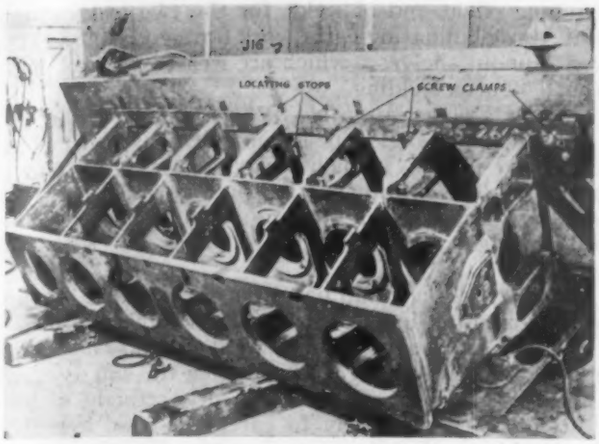


Fig. 23—Block Assembly with One Side Sheet in Place

assembly from the jig, these markings are transferred to the bottom flange of the beams. The pads thus are located correctly, alike on all bases, and considerably cheaper than by individual layouts.

The finished assembly is now set up on a layout table for a complete layout check to ascertain whether there is sufficient stock on all machined surfaces. Any deficiency must be corrected by building up by means of welding before stress annealing in order to avoid a second annealing and sandblasting operation.

The base and the block are designed for a uniform, maximum finish allowance of $^1/_4$ in. on all finished surfaces. By means of the strongbacks and careful welding sequences, distortions, as a rule, stay well within this allowance, in spite of the fact that the base is 208 in. long. Occasionally, however, mostly on the block, human errors and other causes call for a certain amount of rework and correction, which is negligible, considering time and cost, if found before stress annealing.

After the base has passed layout inspection, it is tested for oiltightness by filling it, level with the top, with hot oil.

After passing this test, the base is ready for annealing. To counteract possible sagging under heat and to reduce already existing sag, though within the $^1/_4$-in. finish allowance, two bases are tacked bottom to bottom, after being pulled tightly together by means of C-clamps Two bases in one unit thus enter the annealing oven (Fig. 15). Maximum annealing temperature is 1150° F. The heating and cooling rates are 100° F. per hour. The oven is opened when cooling temperature has reached 300° F. The soaking time is determined by the greatest thickness of any member or section. The annealing temperature of 1150° F. is held four hours for the first inch of maximum thickness and one additional hour for every additional inch or fraction thereof.

As can be seen by those familiar with stress annealing, this procedure follows accepted standard practice.

After removal from the oven, the bases are chipped apart and shot blasted. Any remaining weld spatter on the inside is carefully removed by hand tools. It should be mentioned here that on both base and block, all welding operations are preceded by a generous application of antispatter paint, clearly visible in the photographs. On this type of weldments, where absolutely no spatter must remain on the inside surfaces, antispatter protection has greatly reduced cleaning-labor hours and cost.

Although the base is continually under the scrutiny of the Inspection Department during all of the various steps of fabrication, it is now given a very thorough inspection, including Magnaflux and X-ray testing. It is then painted in a spray booth to protect the beautiful shot-blast finish, which is quite susceptible to rust. The base is then forwarded for final layout and machining operations.

The Engine Block (Fig. 3) is made up from three jigged subassemblies and several smaller, nonjigged subassemblies. The latter consist of the horizontal diaphragms and ring preassembly; the side and end plates, side-cover assemblies, etc. (Fig. 16). Wherever possible, all bolting pads, flanges, lugs, etc., are welded to the preassemblies before these enter the main assembly. This is in line with established and well-known welding procedure concepts, and serves many purposes which can be listed as follows:

1. The over-all shrinkage in the final assembly is lessened in direct proportion to the increase of the amount of welding that can be done before final assembly.
2. Shrinkage on preassemblies can be corrected before entry into the final assembly at a reduced cost.
3. The work can be spread among more welders, eliminating a beehive at the final assembly.
4. Speed of production can be stepped up as more welders can be at work simultaneously.
5. Better and faster mass-production methods can be worked out.
6. Better control methods can be applied, counteracting shrinkage and distortion.
7. Welders can be trained to high efficiency by specializing on one particular preassembly.
8. It makes work distribution in the welding shop more flexible by permitting the use of the preassembly as a fill-in during slack periods or to keep an occasionally idle welder busy.

The three jigged assemblies are listed as follows:

(*a*) *The Bulkhead Assembly* (*Fig. 17*).—Here a $^3/_4$-in. upper plate is centrally welded to a $3^1/_2$-in. bottom plate in a specially constructed, free turning, positioning jig. The lower plate has been flame beveled, both bevels being burned in one pass. Setup time for burning has been reduced to a minimum by a fixed setup relative to the burning torch position, so the plate after lowering into place can be beveled without further torch adjustment (Fig. 18).

The joint, to be 100% effective, is designed for a gradual and smooth transition from a $3^1/_2$-in. thickness to one of only $^3/_4$ in. (Fig. 19) to take care of high-pul-

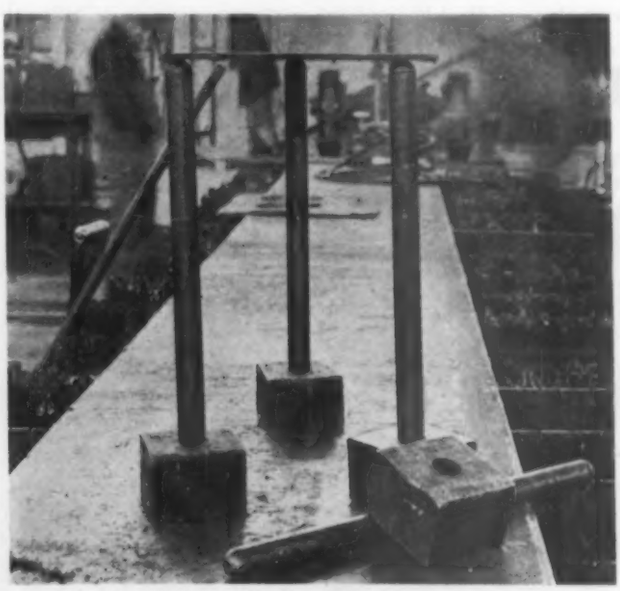


Fig. 24—Horizontal Diaphragm-Positioning Jig Set Up Outside Block to Illustrate Method

sating fatigue stress. The $3^1/_2$-in. thickness is required to locate the crankshaft bearing bolts, but above these bolts it is reduced to $^3/_4$ in. to provide clearance between the cylinders and to reduce unnecessary weight.

Two turning jigs are used to fabricate the bulkheads (Fig. 20). The welder, starting on one jig, welds one side of the joint and then moves to the next jig for the same operation. While welding the second bulkhead, a chipper turns the jig over 180° to back-chip the first weld. The welder and chipper then change jigs again for welding the other side of the back-chipped joint and back-chipping the first weld on the second bulkhead. While the welder finishes the second bulkhead, the chipper removes the finished first bulkhead and installs a new set of plates. While it is being welded, he unloads and refills the second jig to repeat the described cycle. Thus both jigs are kept busy at all times and idle time is cut to a minimum, since the welder does not have to wait for the chipper to finish, or vice versa.

This method is described in detail as an example of modern efficient welding procedures. Only by means of such well-planned methods can the cost of a weldment be held low enough to meet competition with cast iron. As has been pointed out before, it is the last ounce of effort in this direction, the last possible trace of cost reduction, that tips the scale toward success.

After welding, the bulkhead is removed from the jig, the joint is ground smooth on both sides and the bulkhead is trimmed to correct dimensions by flame cutting from a template. This indicates that the plates enter the jig oversize in anticipation of considerable distortion in the $^3/_4$-in. plate, due to the oversize welds required for a smooth transition. The bulkhead is next located in a simple holding jig for the chipping of the groove for the J-weld against the top deck plate of the engine block.

To further illustrate our cost reduction methods, we call attention to the leak stops in the bulkheads, which are semicircular cutouts in way of the horizontal diaphragms (Fig. 21) and serve to open up the close corner formed by two diaphragms, one bulkhead and the side sheet. This cutout provides space for a solid welded plug, which positively eliminates the danger of a leakage from the jacket water space above the diaphragms entering the unwelded space between the wide lower part of the bulkhead and the side sheet. The cost reduction consists in placing the horizontal split between the $^3/_4$- and $3^1/_2$-in. bulkhead plates at the same point with the leak stop, so that the cutout part can serve as a "runout" (tapering off at end of weld) for the two welds of this joint, thus eliminating extra work for a good end weld or even "runout shelves," which are welded on steel pieces burned off after welding.

(*b*) *The Exhaust-Manifold Support Assembly* (Fig. 22) is made up of an angle, one leg of which has been cut and beveled by burning, which always causes a warping of the angle. The welding of a bar on the one leg only, also causes a warpage during welding; and to arrive at a perfectly straight assembly, the following procedure has been devised:

The warped angle and bar after burning and beveling are wedged into the jig so that the assembly has a curve of about $^3/_8$ in. in opposition to what it would have after the welding without jig. Thus, when the sub assembly is removed from the jig, it is perfectly straight without additional forming, ready to enter the main assembly. We should say that the curve is a two-directional curve and the assembly is clamped to be held in two directions.

(*c*) *Main Block Assembly* (*Fig. 23*).—This assembly is started on a strongback jig by placing the two bottom bolting bars against locatings tops and by holding these bars in place by husky screw clamps. The bulkhead assemblies are next located against locating stops and tacked in place. It should be noted here that there are four locating lugs at the center bulkhead—two on either side; but on the other six bulkheads there are only two locating stops—all located at the side toward the ends of the block to permit the bolting bars to contract during welding, at which time all bulkheads will be able to pull away from the locating stops, except the central bulkhead. The diaphragm assemblies are next located by means of a quick-acting locating jig, which consists of four bars and four blocks—the length of the bars exactly locating the diaphragm horizontally, while the blocks hold the bars in proper position. None of the bars and rings are welded to each other (Fig. 24).

In setting up the original locating stops for the bulkheads, the lugs were spaced so as to permit a $^1/_{16}$-in. contraction during welding at the level of the assembled diaphragms and at the bolting bars. The top deck, however, being so much heavier in section, will not contract as much and, therefore, shrinks only about $^1/_{32}$ in. per space, and the deck plate is burned allowing $^1/_{32}$-in. contraction per cylinder hole. To make this setup correct, it is necessary to bend the upper section of the bulkheads slightly toward the middle of the block so that only the middle bulkhead will be vertical and the others will

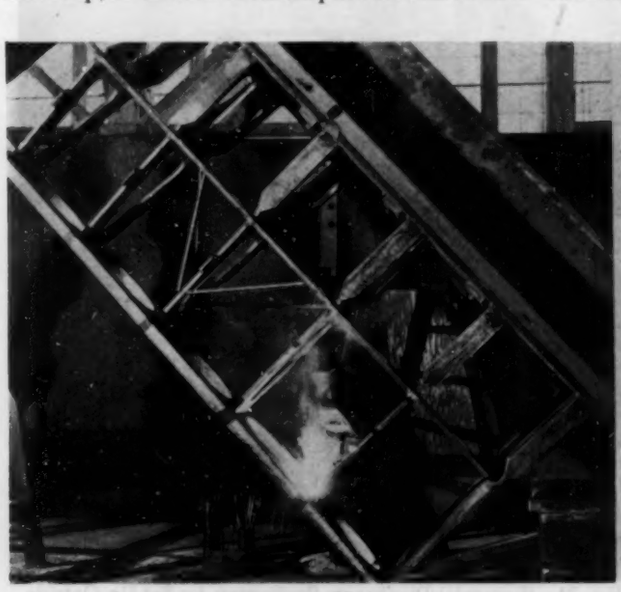


Fig. 25—Block in 45° Welding Position

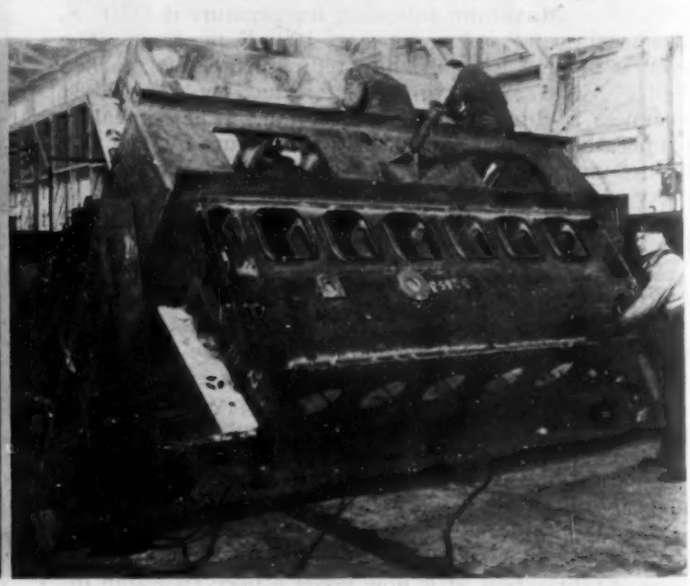


Fig. 26—Two Blocks on Turning Jig

lean toward the center bulkhead, having been forced off the vertical at the diaphragm. During welding, the top deck will shrink a total of $^3/_{16}$ in., whereas the rail and diaphragm levels will shrink $^3/_8$ in. each. It will be noted from the picture shown that the end bulkheads are solid above the diaphragm, since these bulkheads form the end of the water jacket.

The strongback and assembly are now positioned at 45° for the welding of the bulkhead to the deck plate and diaphragm (Fig. 25). It should be noted that in order to maintain proper alignment during welding, the center bulkhead has been braced so as to maintain its proper vertical position by means of diagonal bracing. The welds on the deck plate, as explained before, are back-chipped and are then ground to a smooth $^3/_4$-in. radius. All this work is done while the frame is open, as shown, for easy access. The bulkhead is also welded to the bolting bars. Next, one side sheet is added to the assembly by tacking, after which the assembly is removed from the strongback.

After two block assemblies have been finished, as mentioned above, they are mounted on a special strongback jig, one block assembly being bolted to the top and the other to the bottom of the jig for a perfect balance, permitting rotation of the jig by hand. The jig is open for access to the blocks from the center and is mounted by means of end shafts to special jig supports so that the whole assembly can be rotated as shown by Fig. 26. With the two block assemblies thus mounted, the first side plate is welded, back-chipped and ground at its joint to the deck plate, after which the second side plate is handled in the same manner. The grinding for the second plate is not done on the turning jig but is done on the floor after mounting on individual strongbacks. While still on individual strongbacks, the assembly is set up for the addition of the manifold support, camshaft brackets and end bulkhead pads. In setting up the camshaft brackets, two shafts with locating lugs are used to space the brackets properly for reduction of time in setup (Fig. 27). With the two locating shafts still in place, the brackets are temporarily braced diagonally and are connected with a bar to maintain the alignment after the shafts are removed. This bracing remains on the block until after stress annealing. It should be noted that the bearings of the camshaft brackets are premachined to fit the finished shafts closely before they reach the block assembly. There is sufficient stock on these bearing surfaces for a final finish machine operation. The camshaft brackets are also predrilled for lubrication.

With these parts tacked to the assembly, the block and strongback are positioned for welding all the parts mentioned, after which the end covers, side covers, chain brackets and other items to finish the assembly are added (Fig. 28).

The block is next set up on the layout table for a check for sufficient stock for future machining operations.

After passing this check, it is hydro-tested for 75-lb. pressure. In view of the leak stops provided, leakages very rarely occur. After the hydro-test, the block is stress annealed. The block in itself is strong enough to eliminate any sagging during the stress-annealing process, so this assembly can be sent into the oven alone, without additional reinforcing.

After stress annealing, the block is shot-blasted, cleaned of any remaining weld spatter, and carefully inspected for cleanliness, welding defects, etc.

Fig. 27—Positioning Shafting for Camshaft Brackets

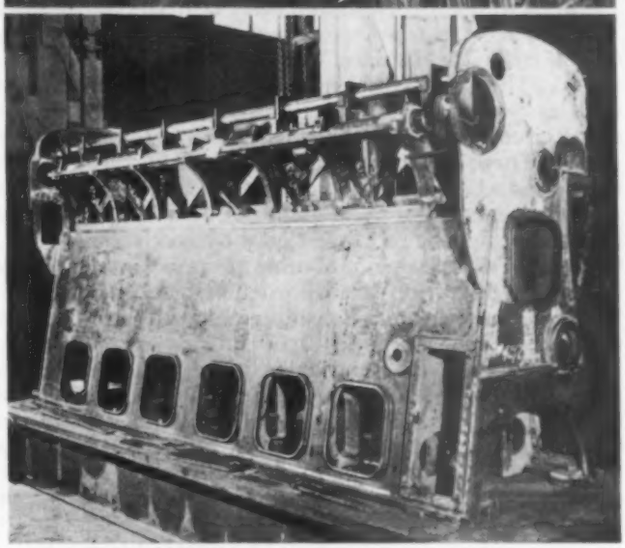


Fig. 28—Finished Block Assembly Just Before Removal of Positioning Shafts. (Note Temporary Bracing on Brackets)

After paint spraying, it is forwarded for the machine operations.

Conclusion

All shape burning, in preparing the various pieces that go into the assembly, is done from steel or steel-lined wooden templates by a No. 41 Travograph Burning Machine.

It is to be understood that in the foregoing description of the manufacture of the assemblies, only the main steps are mentioned and that there are many more small in-between steps which are not mentioned, being of little interest.

Positioning for welding is, of course, best done on full-rotating, power-driven positioners. Some of our photographs show positioning on the floor, which was necessary since there were not sufficient positioners available at the time the pictures were taken.

We have at the Hendy plant, besides welded Diesel engines, a large production of weldments for turbine housings, gear boxes and gears, turbo generator bases, housings, frames and oil-field pumping equipment.

Flame-Hardening Setup for Small Machined Parts

By William B. Sharav*

A VERTICAL flame-hardening installation used by a well-known manufacturer of materials-handling equipment has overcome the distortion that resulted from the furnace hardening of small machined parts. This flame-hardening setup handles small parts such as gears, rollers, wheels, shafting, small pins and other circular parts having diameters between $1^1/_2$ and 12 in. These parts, formerly hardened by furnace heating, followed by a water quench, were often so distorted after hardening that they could not be used, and in some instances could be reclaimed only by costly grinding operations. The flame-hardening process virtually eliminates such distortion due to hardening. As a result, both the rejection rate and finishing costs are substantially reduced.

The spin-hardening method is used for hardening these parts. With this method, the piece to be hardened is rotated rapidly while being heated by a series of stationary oxyacetylene flames. When the part has been heated to the correct hardening temperature, the flames are withdrawn, and a spray of water is directed upon the work while it is still spinning. This spin-hardening method assures a uniform case on all areas of the part.

* Development Engineer, The Linde Air Products Co.

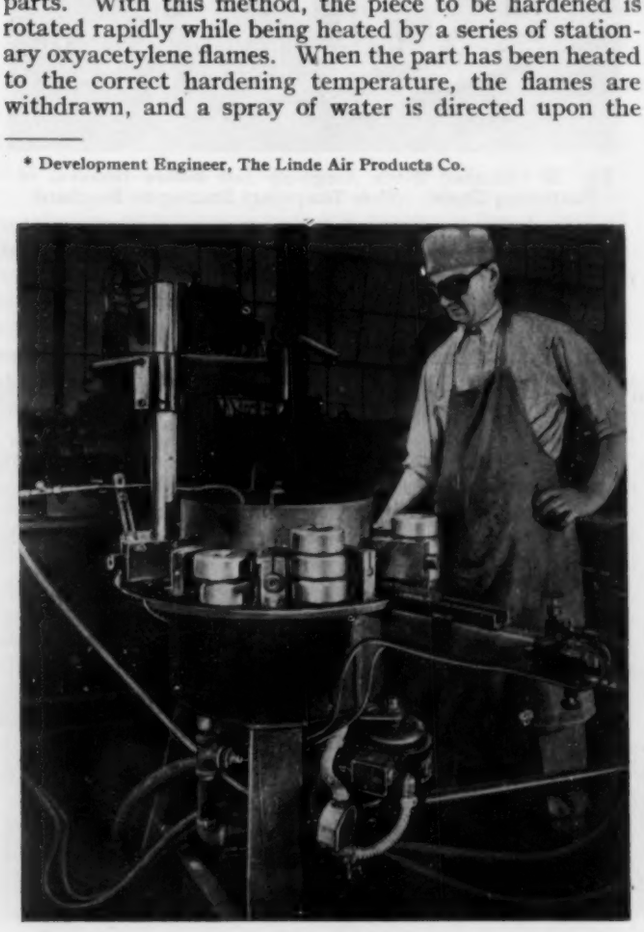


Fig. 1—Control Box Showing the Automatic Solenoid Switches

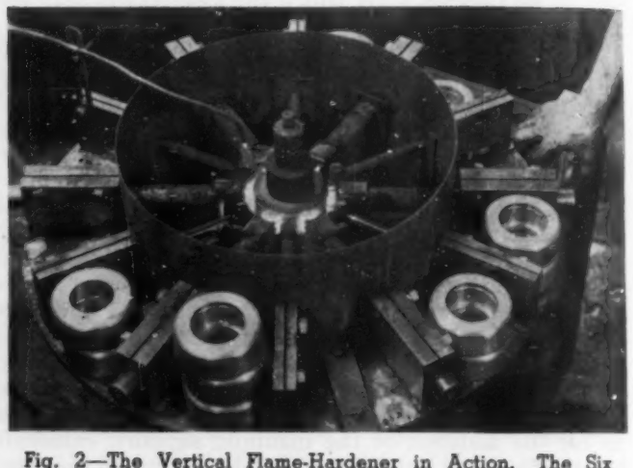


Fig. 2—The Vertical Flame-Hardener in Action. The Six Heating Heads Are Being Used in the Hardening of a Machined Roller

This machine is equipped with six flame-hardening heads. These are separate adjustable units, however, and any combination of them may be used, depending on the amount and type of heating necessary. For hardening parts under 2 in. in diameter, such as shafts and pins, only three heating heads are used. For hardening relatively thin pieces, the number of heating flames per head can be reduced by replacing the rows of unneeded flame tips with plugs.

The complete operation is subject to exact procedure control made possible by the use of a special control device which can be adjusted for each hardening job. The control box and timer are set according to specifications worked out by the engineers, after which the cycle of heating and quenching becomes fully automatic. The heating flames and the water sprays are then turned on and off automatically in correct sequence by solenoid valves. The operator merely positions the work to be hardened and pushes a button to start the sequence of heating and quenching.

The work is clamped in position in several ways. For small parts, such as small-diameter shafts and wheels, a quick-acting centering device is used. For larger work, a tapered center fits over the spindle and centers the work. This center is made heavy enough to hold the work firmly in the machine.

After the parts are hardened, they are tested with a Scleroscope. The hardness ranges between 71 and 75 on this scale, which is equivalent to a Brinell hardness of about 540. The depth of hardness varies from $^1/_{32}$ to $^1/_8$ of an inch, and can be controlled as desired.

Welded Pressure Vessels in the Oil Industry*

By J. C. Holmberg†

THE oil industry has, since the discovery of oil, developed into one of the major industries of the world. Without oil and its products modern industry and modern warfare could not exist.

When petroleum was first discovered, the main thing of interest was that a substitute for whale oil as an illuminant had been found and early day refineries were built for the sole purpose of distilling off the kerosene, or coal oil as it was often called, and permitting the other products, such as lubricants and the volatile gasolines, to go to waste.

Needless to say, this picture has changed and oil is worked for products that just a few years ago were unknown. This change in ultimate end product has produced great changes in processing procedure and these have, in turn, made equipment modifications and new developments a common occurrence in the refining industry.

The earliest oil refineries were, by modern standards, extremely crude affairs. They were essentially ordinary pot-type stills consisting of nothing more than a closed container, wherein the crude oil was heated, and a water-cooled condenser which liquefied the gaseous products. The quality and physical characteristics of this product were controlled by the skill of the stillman who worked largely by rule of thumb and, by his experience, was able to make marketable merchandise.

In these early days, after a run from a still, all the products other than kerosene were discarded—usually by dumping the residuals into the nearest creek or run.

This condition did not continue for long before it was discovered that some of these sludges and other products had certain valuable properties that had commercial values. It was found that lubricants of higher quality than the animal fats then common were being wasted, and that solvents of high caliber were being dissipated into the atmosphere.

The equipment used in those days and up to the close of World War I, was, by modern standards, primitive as to design and construction. It was usually built by some local boiler shop from relatively thin gage plate and was of riveted construction because welding was, except for forge welding, more of a novelty than a tool.

World War I saw welding come into its own as a method of jointure. It grew under duress of war when the need for projectiles far exceeded the then accepted manufacturing procedures, and by Armistice Day it had proved itself a success.

The refining industry was the greatest beneficiary of this new knowledge. By now they had amassed a great deal of technical knowledge; had developed new processing techniques, and evolved theoretical reactions and processes that were to change, in a short span of time, the entire trade; and it was these new thoughts that were to give welding its great impetus in the oil industry.

These new theories and processes called for two things that precluded the use of riveted construction. These were temperature and pressure.

The temperatures reached a point where 900° F. was common and the pressures became so high that the shell thicknesses were such as to prevent satisfactory joint construction by means of rivets. Also, the internal construction of most of this equipment was so complicated that a smooth interior was necessary—something impossible where butt straps and rivets were involved.

The law of supply and demand now started to function. The refiners' need saw the establishment of organization and companies whose function it was to supply the requirements of the oil industry. One of these new companies was our own.

The development of welding soon caused the abandonment of the construction of riveted boilers and tanks and the development of welded vessels and the strategic location in the center of the Mid-Continent oil field indicated the advantages of concentrating on the development of modern refinery equipment, working in close conjunction with the research and engineering departments of the large producers.

At the present time, our plant has around 400 employees in the plate shop,

* Presented at the December 7th Meeting, A.W.S. Chattanooga Section.
† Metallurgist, Tulsa Boiler & Machinery Co., Tulsa, Okla.

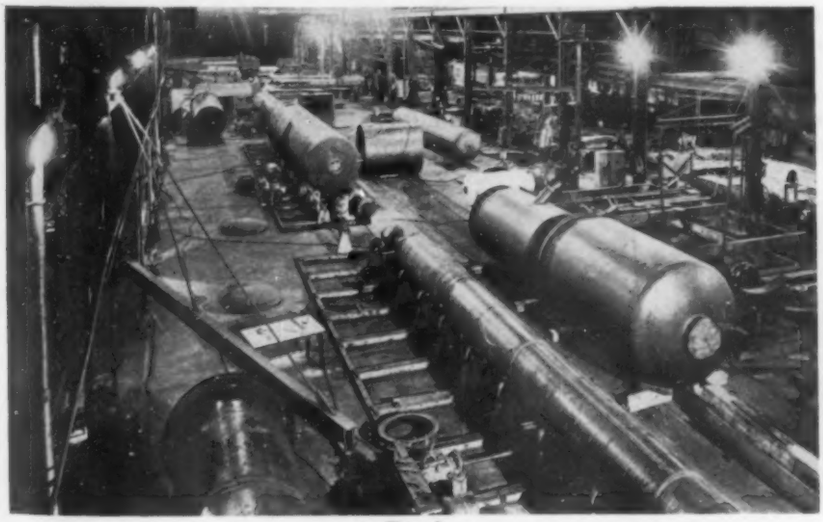


Fig. 1

Fig. 2

structural shop and machine shop, working on such items as condensers, absorbers, fractionating columns, reboilers and similar pieces of apparatus. Some of this equipment can better be described by means of illustrations.

Figure 1 is a view taken at night showing the main bay of the plate fabricating shop. In this is a general assortment of various types of vessels as manufactured for the oil industry.

Figure 2 shows a vessel that is, so far as we know, one of two that we built and were the largest one-piece vessels ever shipped by rail. This tower was $13^1/_2$ ft. in diameter and 145 ft. high. The shell thickness was $1^1/_8$ in. Each tower was fitted with 50 trays and the shipping weight of the two towers was 1,006,674 lb., or practically 252 tons each.

Figure 3 shows a heating unit consisting of 1050 U-shaped tubes of $^3/_4$-in. x 14-gage material. Many processes involve the use of a large number of these units, especially in towers of large size.

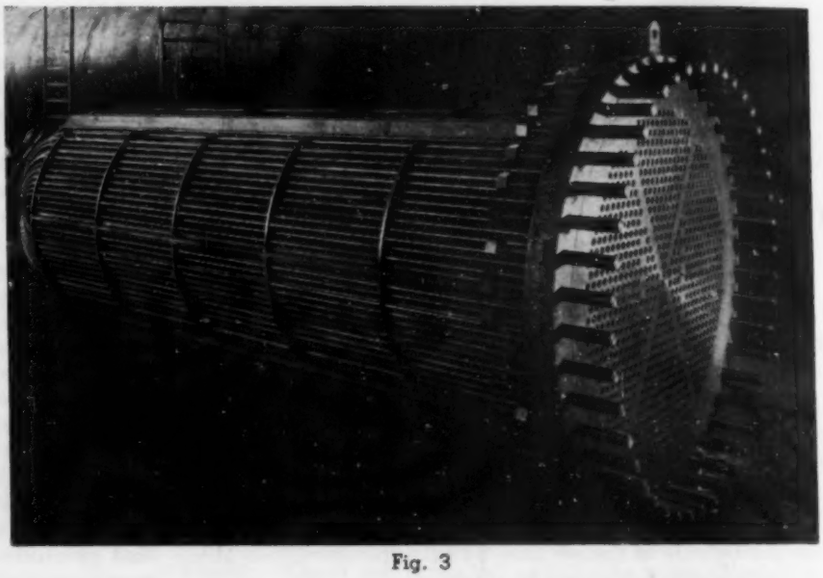


Fig. 3

Figure 4 is a rather scenic view of a young trainload of vessels that are termed stabilizers. Each of these vessels are 6 ft. in diameter and 100 ft. tall. This type of vessel is usually used in multiples of two or more.

Figure 5 shows a tower 12 ft. in diameter by 150 ft. tall. The weight of this vessel, complete with trays, etc., was 156 tons. The construction design was governed by transportation clearances.

This illustration shows a view in the shop during the construction of these large towers. This also shows some of the trays and the bubble caps and other internal parts that form a part of the completed vessel.

Figure 6 shows another type of tubular heat exchanger. The oil industry uses a great number of these units. They are built of many different kinds of material and many different combinations and variations as to design, all depending upon their ultimate uses and requirements. Many have internal parts of alloy materials such as monel, nickel, stainless steel, etc. Others are built of aluminum or copper alloy and service requirements dictate all construction details.

Figure 7 shows three exchangers built entirely of Monel metal. These operate at rather high temperature and 2000 lb. pressure. Monel was used because of its corrosion resistance to the type of liquid being processed as well as its ability to withstand the temperature and pressures. The flanges were 6 in. thick. In the background is an odd-shaped storage tank being tested on the test block.

Figure 8 shows a field storage tank with hemispherical heads. This vessel is built of $^5/_8$-in. thick steel plate, is 12 ft. in diameter and 50 ft. long overall. It is one of the several that was built for a butadiene plant in West Texas.

Figure 9 is a fractionating column 12 ft. in diameter and 150 ft. long, built of 1-in. thick material. A peculiar thing in connection with these vessels is that only 12 to

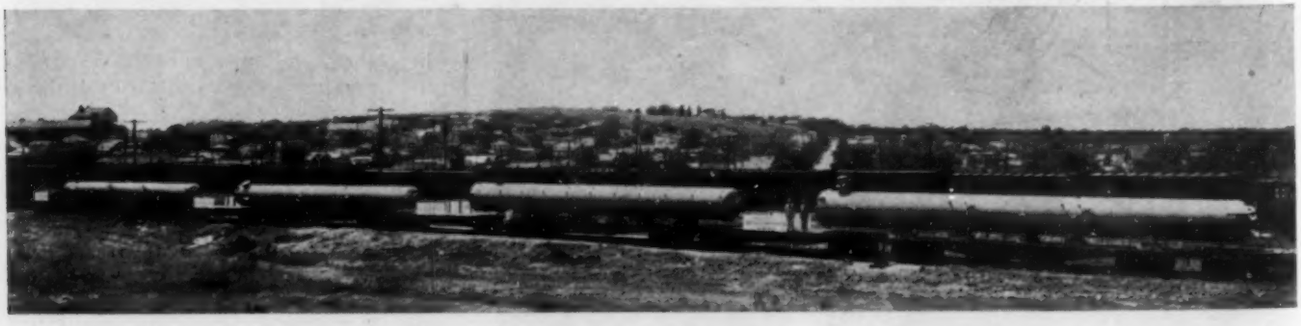


Fig. 4

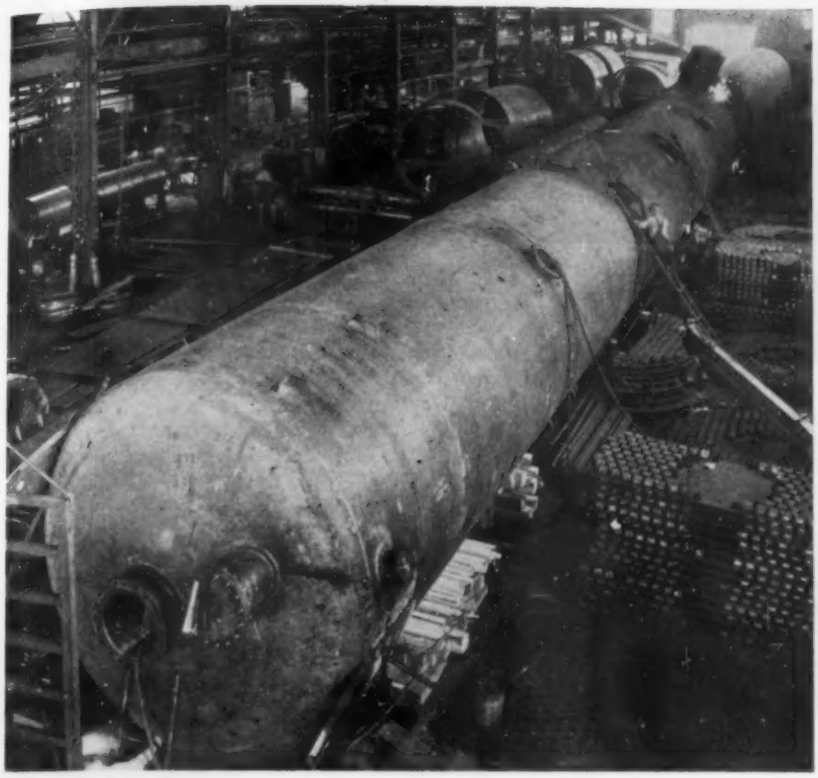


Fig. 5

Fig. 6

15% of the total amount of welding done on these is in the form of seam welding because of the complicated internal parts and construction. For this reason, automatic welding finds little application and the work is all manually performed. The view shows the vessel as loaded for shipment. Again railway clearances were a big factor and, in order that it reach its destination in West Texas, it was necessary to send it North into Kansas then West and, finally, South to the erection location.

Under the pressure of war production quite a bit of alloy material was used for lining and certain other requirements. This was because the processes were stepped up until they became chemical instead of refining operations. Under these conditions, mild steel could not withstand the corrosive conditions and high-alloy linings were installed in certain parts of the vessels and, in some cases, even entire small units such as exchangers were built from these materials.

However, now that peace is again with us, the oil companies do not have the demand for either high octane gasoline nor the synthetic chemical solvents and are gradually returning to standard production. The natural result is that the expensive and complicated pieces of apparatus are being retired from use and the simple and cheaper equipment is being restored to operation. This will probably hold true for some little time, or until the operators have had the opportunity of further improving the wartime units to where they will be commercially economical to operate.

A big factor entering into the use of high alloys in the oil industry is the philosophy of the refiners. You might say it is just opposite of that found in chemical, food, soap or allied operations. In these, rather than take a chance, stainless is often used to extremes; used in places where it might not be needed and richer alloys used where cheaper ones would serve as well. The oil business is the other way. The men of the industry are, by the very nature of their lives, gamblers; always have and, no doubt, always will take chances that would scare a conservative businessman. It, therefore, is not strange to find all construction of mild steel and

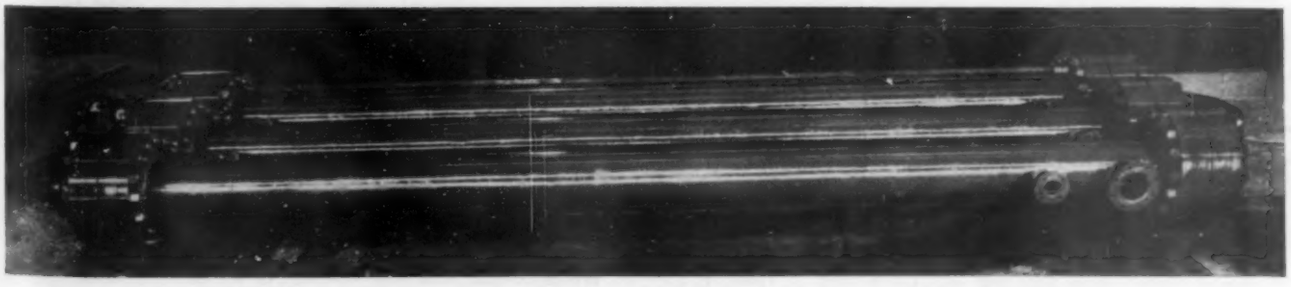


Fig. 7

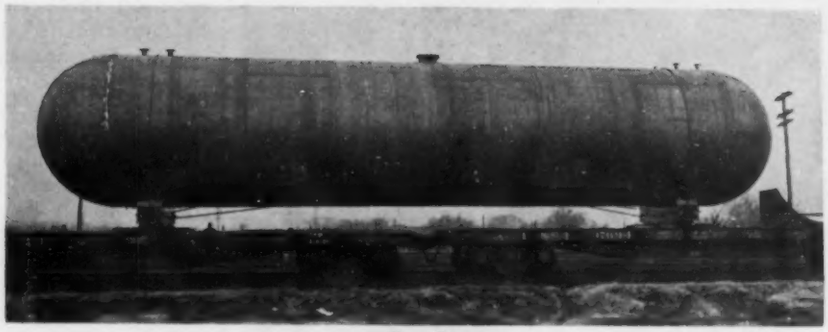


Fig. 8

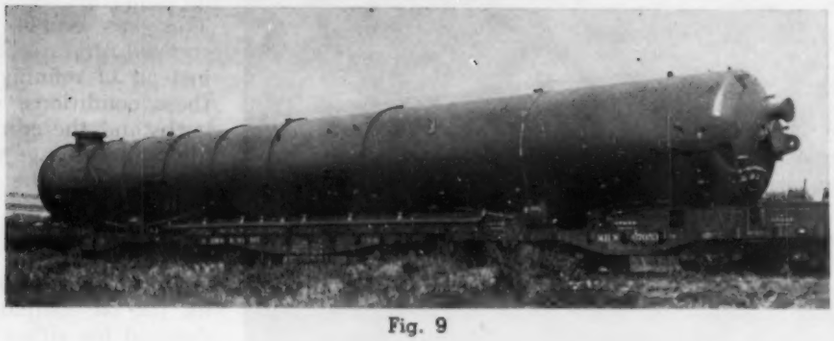


Fig. 9

then when trouble arises from either corrosion or erosion to replace that particular piece or area with alloy material. This is shown by the fact that towers will have only certain parts of their inside surfaces clad with a lining or certain operating parts built of stainless.

Before closing, it might be well to mention a spot where high alloys have by now become very popular. This is in valve relining. The oil, as it is pumped from the ground, carries with it in suspension, a considerable quantity of abrasive sand and foreign matter. This has a cutting action and soon destroys the seats and operating parts of valves, pumps and kindred equipment. Therefore, a big small business has grown up.

Every town has a weldery or two that makes a specialty of repairing and lining these worn parts with Hastelloy, Stellite or one of the many various corrosion- and abrasion-resisting alloys. These little shops annually save the oil companies vast sums of money and, in turn, they are in their small way advancing the art of welding as well as the company I have the honor to represent.

(*Continued from page 312*)

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Discussion on "Welding of Propulsion Shafting"*

By J. T. Vann†

THE authors have presented a clear and accurate statement of the development and production of ship shafting by welding centrifugally cast steel tube sections as furnished by American Cast Iron Pipe Co. A few items of data in connection with the castings require some further elaboration.

In Table 1 of the paper are given chemical analyses of six shaft castings. These six castings were of the first made and were experimental heats. The data do bring out the authors' point that segregation was not unduly great. However, alloying with molybdenum and vanadium (shafts 2, 3 and 4 of Table 1) was found to be unnecessary to meet the required physicals, and all subsequent castings were made of plain-carbon steel. The aluminum contents shown in Table 1 were purposely varied in these experimental casts, but this was later standardized to a ladle addition of $2^1/_2$ lb. of aluminum per ton which gave a residual content of about 0.05 to 0.06% Al. As eventually standardized, the steel used for casting these shafts is a plain-carbon steel of 0.35% max. carbon, about 0.90% manganese and 0.50% silicon. The higher-than-normal silicon gives better castability and resistance to oxidation without adversely affecting weldability.

The physical test values given in Table 2 of the paper are representative of the first lot of 9-in. O.D. cast shafting produced. A later order of 16-in. O.D. shafting for U. S. Coast Guard Cutters was produced of the same analysis with standardized practice which gave the following average test results on 0.505-in. tensile bars cut from the actual castings: tensile strength, 75,000 psi.; yield point, 44,000 psi.; elongation, 27.0%; reduction of area, 45.0%.

It may be of interest to readers of this paper to have additional details of the production of these thick-walled centrifugally cast steel tubular sections. The 16-ft. lengths of shafting or tubes are centrifugally cast in sand-lined molds. After ramming and drying, the mold is placed in a horizontal casting machine. The ends of the mold are closed with oil sand cores, which are keyed into the open ends of the mold.

The flask-mold combination is brought up to the proper spinning speed. The metal is introduced through a refractory orifice trough, which is inserted into one end of the mold. When the metal has completely solidified, the spinning is stopped and the casting allowed to cool slowly in the sand-lined flask before stripping.

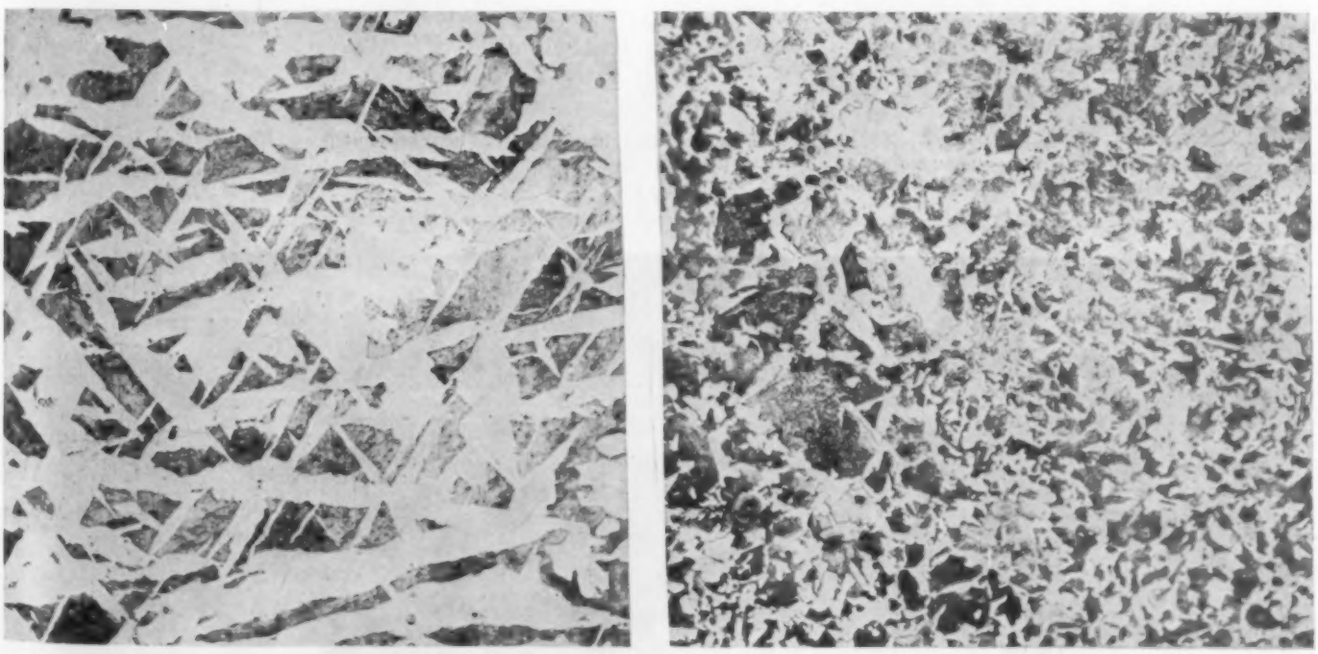
The steel is acid electric, produced to the specifications given in the paper. After rough machining, the shafting is given a careful visual and Magnaflux inspection and heat treated before welding. Either normalizing and

Manual Welding

Current	Alternating except first pass
Preheat	450–500° F.
First pass	$^5/_{32}$ in. A.W.S. E-6010 205 amp. at 30 v., reverse polarity d. c.
Remaining passes:	
$^3/_{16}$ in. A.W.S. E-9020	215 amp. at 30 v., a. c.
$^1/_4$ in. A.W.S. E-9020	245 amp. at 35 v. a. c.
Time	16 hr.

Automatic Welding

Current	Direct
$^1/_4$ in. A.W.S. E-9030	325 amp. at 28/30 v. straight polarity
Preheat	450–550° F.
Time	8 hr.

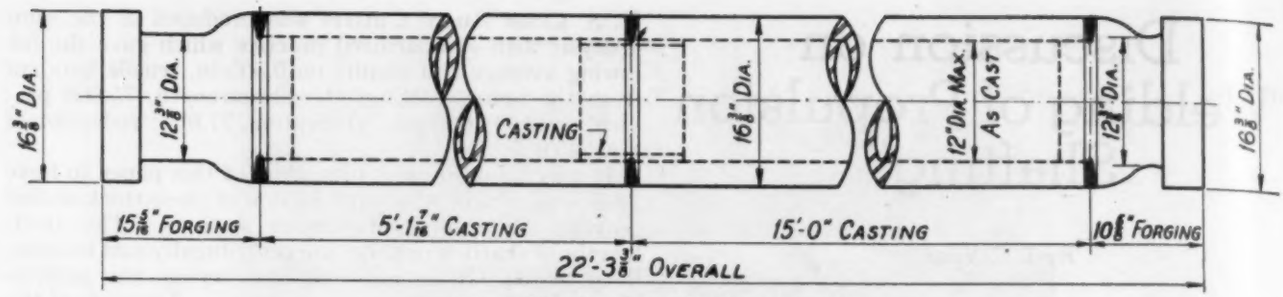


A B

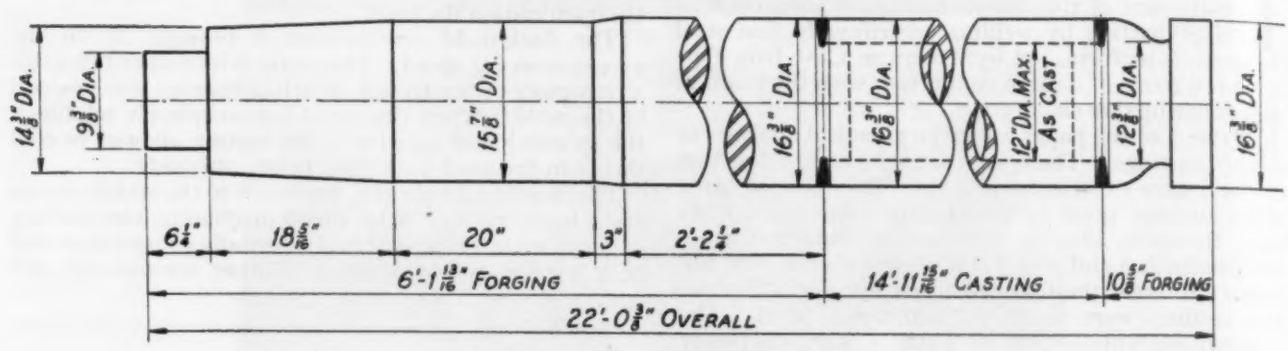
Fig. 1—Microstructures of 16-Ft. Long Shaft Castings. (*A*) As-cast. (*B*) Annealed. Etched × 100

* Paper by Hugo W. Hiemke and Comdr. James C. Blake, published in THE WELDING JOURNAL, November 1945.

† Testing Engineer, American Cast Iron Pipe Co., Birmingham, Ala.



Line Shaft—Rough Machined



Tail Shaft—Rough Machined

Fig. 2

Weld Properties

	Manual						Automatic					
	Tensile, Psi.	Yield, Psi.	% Elong.	% R. A.	Impact, Ft.-Lb.	Bend	Tensile, Psi.	Yield, Psi.	% Elong.	% R. A.	Impact, Ft.-Lb.	Bend
Longitudinal bend—weld at center	...	...	...	...	..	120°	...	...	...	...	..	180°
Longitudinal bend—weld at center	...	...	...	...	..	120°	...	...	...	...	..	180°
Transverse — all weld—tensile	81,700	69,300	22.8	52.8	..	...	77,500	50,700	27.1	56.7	...	...
Transverse — all weld—tensile	79,300	70,700	18.8	41.7	..	...	79,200	52,500	26.3	57.8	..	...
Longitudinal — weld at center—tensile	76,200	43,400	...	...	..	...	76,600	50,300	...	...	..	...
	...	66,500	...	...	..	...	...	51,800	...	...	..	...
Longitudinal — weld at center—tensile	75,700	43,500	...	...	..	...	76,700	48,900	...	...	..	...
	...	66,900	...	...	..	...	...	50,600	...	...	..	...
Charpy—weld center	...	...	...	...	32	...	...	...	...	...	43	...
Charpy—fusion zone	...	...	...	...	40	...	...	...	...	...	35	...

In processing, the welds were magnafluxed after the first pass, stress relieved by local heat treatment at 1150–1200° F. for 6 hr., and then remagnafluxed after the excess weld metal had been machined off.

Figure 5 shows the structural make-up of a manual weld.

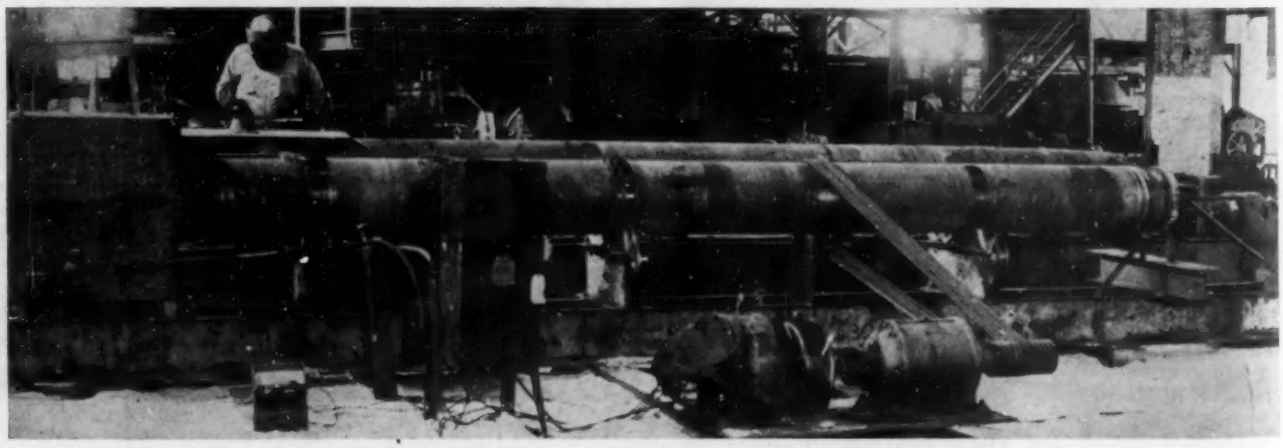


Fig. 3—Picture Showing Hand Welding and Stress Relief

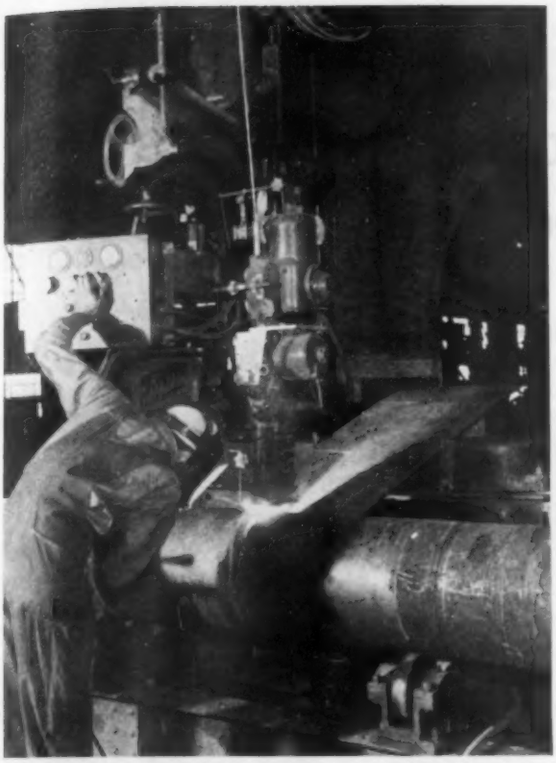


Fig. 4.—Picture Showing Automatic Welding

tempering, or annealing, has been found to be satisfactory (Fig. 1).

Some interesting experience in this field was gained in the production and fabrication of the shafting for Coast Guard Cutters. The assembly for each ship consists of a line shaft and a tail shaft. The line shaft is composed of two lengths of centrifugally cast carbon steel tubing welded together with Specification 49-S-2 (Int.). Class AN solid forged couplings welded on at each end. The tail shaft is made up of a length of centrifugally cast carbon steel tubing with Class AN solid forged coupling welded to one end and a Class AN solid tapered forging at the other (Fig. 2).

The welding of Class AN (3.25/3.50 Ni) forgings to the carbon steel shafting presented an interesting problem. According to information at the time, this had never before been done. Based on research work done by the Engineering Experiment Station at Annapolis, Md., a special welding technique was developed which gave excellent results.

Welding was both manual and automatic. In either case the castings were rough machined to $16^{3}/_{8}$ in. O.D. and after Magnaflux and visual inspection were machined at the ends for welding.

After the machined pieces had been assembled, they were tack welded in position and placed on welding jig rollers, driven by an electric motor. The speed at which the shaft revolved was controlled to suit the welding.

Typical test welds of both types were made and submitted for inspection prior to the execution of the order. Complete test results as obtained from samples taken from the test welds are listed in the preceding table.

As a result of executing three orders for ship shafting under Navy Specifications and special requirements, the American Bureau of Shipping has approved a specification for centrifugally cast shafting for ships which come under their jurisdiction for inspection. Apparently, the ground work has been done which will enable ship owners in the future to take advantage of the superior quality and economic features of centrifugally cast shafting.

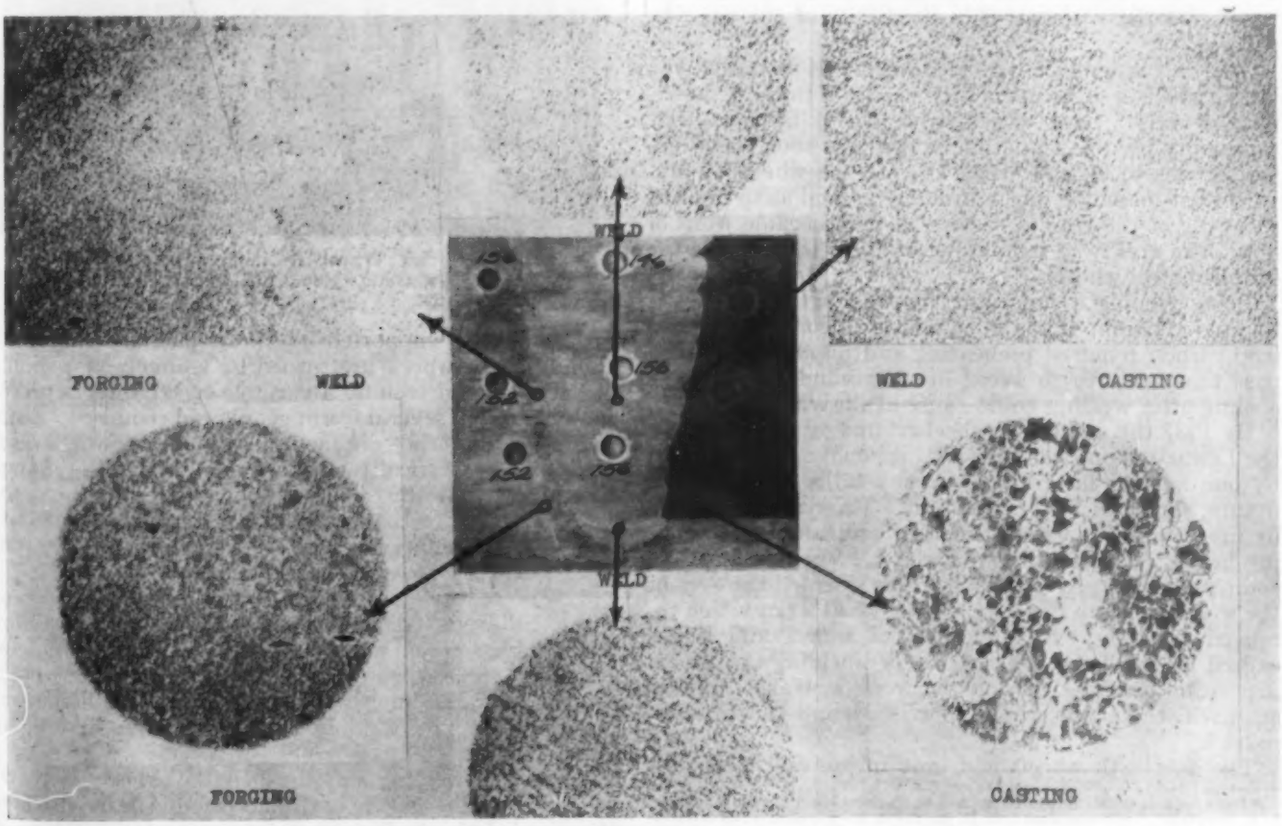


Fig. 5

Rebuilding Locomotive Wheels by Automatic Shielded Arc Methods*

By L. K. Stringham†

ONE of the most recent applications of the submerged automatic metallic shielded arc process is the rebuilding of wheels for mine locomotives. This work, conducted at the Pittsburgh Coal Co. Library Shops, resulted in much faster welding, denser weld deposits for increased resistance to wear and breakage and a cost reduction over the former welding procedure.

The amount of wear on mine locomotive wheels due to heavy loading on steep grades makes wheel maintenance an item of major importance. It is thus natural that the possibility of rebuilding these wheels by arc welding was considered early in the development of the arc welding process. In consideration of the amount of metal to be deposited in the rebuilding of these wheels it was likewise natural that they offered a ready application of the automatic metallic arc method when it was first developed. Many such automatic welding head units have been so used.

Since 1933 heads with automatic wire feed have been in use at the Pittsburgh Coal Co. Library Shops for this purpose. At the time of this first installation, and at several times since, experiments have been made to determine the best wire and welding procedures with which to rebuild the wheels within the limits of the bare arc process.

The first automatic wire feed head was mounted on a lathe, which was subsequently used for turning the rebuilt wheels. Cast wheels with shrink-fit tires were commonly used at that time and it was soon found advantageous to tack weld the tires to the wheels to prevent their loosening during welding as well as to prevent throwing of the tires in service as they became worn or hot. The ability to rebuild increasingly favored the use of rolled steel wheels.

In developing a procedure for welding the wheels it became apparent that the composition containing 0.50–0.80 carbon required preheating and maintaining interpass temperatures to avoid breakage and that uneven cooling after welding could cause explosive breakage.

By 1937 the volume of wheel rebuilding to be done at the Library Shops was such that it could not be handled by one welding head mounted on a lathe and a special fixture, shown in Fig. 1 was built. This view shows the fixture rebuilt to handle shielded arc automatic welding heads. This fixture with the bare arc process was completely enclosed in a hood which shielded the eyes of the workmen from the bare arcs and had a fan which removed the considerable volume of smoke and fumes caused by welding. By completely shielding the arc by depositing granular flux on the work just ahead of the arc itself, the hoods were unnecessary and therefore removed.

The axle with wheels and gear in position rests in a bronze bearing supported by an air jack for easy positioning The wheels are turned by a chuck on a sliding shaft which is driven by a variable speed, direct-current motor through several worm gear speed reducers. Automatic welding heads are mounted on a framework which is adjustable vertically to compensate for wheel diameters and horizontally by means of screw feeds to move the units back and forth across the wheel faces. Gas flames were used for preheating and heating during welding, but these burners have since been removed.

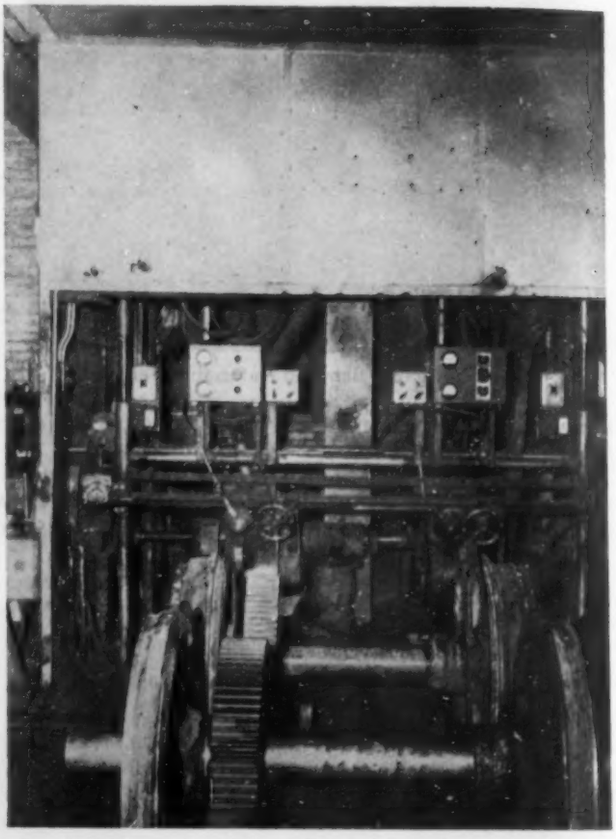


Fig. 1—Fixture for Wheel Rebuilding by Shielded Arc Process of Automatic, Metallic Shielded Arc Welding

The procedure developed with the open arc equipment was as follows: The wheels were mounted in the fixture and the gas burners turned on full to bring the temperature of the wheels up to 500–550° F. in about one hour, at which time welding was started. The gas flame was reduced during the welding process which required on an average about 7½ to 9 hr.

When the welding was finished the wheels were removed from the fixture and placed under a hood where they cooled slowly for about 5 hr. to a temperature of 150° F. after which they were allowed to cool in air. A

* Data for this article furnished by A. Lee Barrett, Maintenance Engineer; A. E. Burgesser, Superintendent; C. D. Ramsden, Shop Engineer, all of Pittsburgh Coal Co. Library Shops; and H. E. Cable, Welding Engineer, The Lincoln Electric Co., Pittsburgh Branch Office.

† The Lincoln Electric Co., Cleveland, Ohio.

1/4-in. diameter, copper-coated wire having the analysis: carbon, 0.50–0.60; manganese, 0.60–0.80; silicon, 0.16–0.20 was found to give the best results with a deposit about as hard as could be readily machined when applied with a finish pass temperature of 600 to 650° F. With this practice, average yearly records showed that the rebuilt wheels gave about 85% of the wear of new wheels or tires at a cost of about half that of new tires or 40% of that of new rolled wheels.

At the suggestion of welding engineers of The Lincoln Electric Co., a trial application of their "Lincolnweld" was effected. In this process the arc is completely covered with a granular flux.

Since the automatic heads then in use were not completely amortized and to determine accurately the comparative value of the new process a fairly complete investigation of the ultimate possibilities of the bare arc process was undertaken and a simple but accurate system of records for determining individual wheel performance was set up.

At the start of this investigation the procedure was as outlined above. Careful checking of temperatures indicated that preheating could be eliminated if gas burners were turned on full at the start of welding and kept on full for about 2 hr. to bring the wheel temperatures up to 700° F. At the end of this period, burners were reduced to maintain this temperature which is sufficient to relieve the stress set up by welding.

Experiments with cooling rates following the welding indicated that they have no appreciable effect on the hardness of the deposit which was determined to be directly related to the temperature of the wheel during the deposit of the last two layers of weld metal. Data on bare arc welding shown in Table 1 are based on the improved procedures. The average wheels are built up 1 to 2 1/2 in. on the diameter and the wear is not at all uniform.

Table 1—Timetable Comparison (Average 30-In. Wheels), Per Set

Process	Preheat	Weld, Hr.	Machining, Hr.
Open arc	None	8 1/2	8 1/2*
Submerged arc	None	3 1/4	2

* Done concurrently with welding operation by welder operator.

Machining of the bare arc weld deposits showing hardness greater than 39 Shore was very difficult because of hard spots which caused chattering and broke tool bits. Hard spots existed in wheels averaging as low as 32–36 Shore because of oxide inclusions but machining was practical at hardness 36–38 Shore maximum.

Fig. 2—"Lincolnweld" Shielded-Arc in Operation

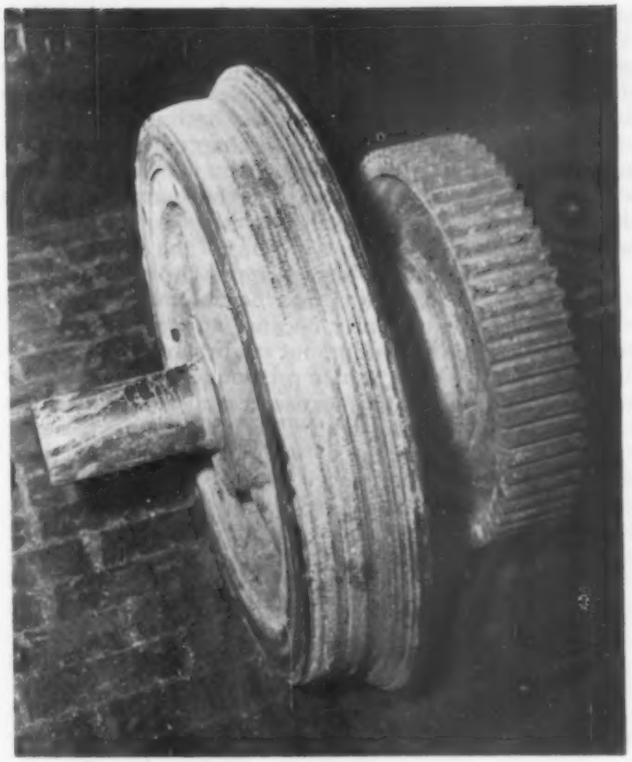


Fig. 3—Close-Up of Typical Wheel as Rebuilt by the Shielded Automatic Shielded Arc Process

During this period of investigation of the open arc process, preparations were made to handle the new problems posed by application of the new process and a single "Lincolnweld" automatic welding head was set up interchangeably on the fixture. It was operated briefly at intervals to determine its behavior under various conditions.

Comparisons of open arc and flux-shielded arc process have had to be made with the fact in mind that with the open arc setup the same operator ran both welding machines and a single tool lathe for wheel turning. While machining time was sharply reduced by the much more accurate contours and homogeneous deposits produced by the new process, the faster welding requires the full attention of the operator and the turning must be done by a lathe hand.

The principal problem was that of handling the granular flux under which the arc is submerged. The flux must be continuously supplied in such volume as to completely cover the arc. The flux is a manganese-silicate composition, prefused, crushed and sized to approximately 10 x 40 mesh and weighs approximately 140 lb. per cubic foot. In ordinary cylindrical welding only sufficient flux is deposited on the work to make a triangular pile over the arc, but this proved impossible where it was desired to weld out to the edge of the rim and up the sides of the wheels in rebuilding flanges, some of which are worn almost completely off.

It was thus apparent in the first trials that the flux must be supported across the whole face and beyond to a depth greater than the height of the flange. This is accomplished by means of flanged, cylindrical dams illustrated in Fig. 2 which show the arc in operation (the number "23" is on the flux dam and the arc is immediately above it in this view). Dams are made up for each diameter of wheels and are held on by bolts through holes cut in the web of the wheels.

There was then the problem of returning the unfused flux to the top of the wheels as a substantial volume, up

to 60 lb. per minute on each wheel, must be handled. A conventional vacuum-cleaner type flux recovery unit of large size was tried but proved inadequate to handle the required volume so a bucket elevator was made to fit the job. Flux is taken from the bottom of a hopper installed below floor level and discharged into an overhead hopper in which a sloping screen is installed. This separates the fused flux into a side chute and discharges the unfused flux through suitable ducts and small hoppers to the tops of the wheels in front of the arcs.

There was also the problem of removing the fused flux from the weld. This was first accomplished by hand with considerable difficulty because of roughness of the first pass due to the boiling out of dirt and oxides from the old surface. Where some previous open arc deposits remain on the wheel they cause gas holes in which the flux is trapped and held tightly. With a little experience this was almost eliminated by improved welding procedures which gave a smooth bead, but small rotating hammers had to be installed which impinged across the whole face of the wheel about 90° ahead of the arc. The rotating hammers have since been replaced by small pneumatic scaling hammers which knock off any fused flux that does not fall free. The fused flux falls with the burned flux into the floor hopper and to the bucket elevator which carries it to the overhead hopper where it is separated as previously mentioned.

With the much higher heat input and metal deposition rates with this process it was necessary to make some changes in the wheel-turning drive to increase peripheral speeds. This was done by changing gear ratios in the reducer units. Welding was done in the experimental stages for short periods with currents as high as 900 amp. However, it was found that lower arc currents give better control of deposit contour and permit the fused flux to drop free or be easily removed. The natural air cooling of the wheels kept the temperature down to 650–700° F., at which the deposit obtained by this process has a desirable hardness for machinability. At the higher current settings, fused flux stuck very tightly to the weld, and metal deposition rates exceeded the ability of the molten metal to freeze before the turning wheels placed the pool in a position sufficiently off the horizontal to allow metal flow.

It was also apparent early in the shielded arc test runs that the heat input of welding at 600–650 amp. applied rapidly around the wheel was uniformly raising the temperature of the whole wheel so rapidly that no auxiliary heating was required. An air or vapor blast was considered for cooling as a means of increasing hardness, but this thought was discarded because the deposit must be maintained in a machinable state.

The use of all new flux—discarding all flux fused on each pass immediately—appeared as the high cost item of the process. The possibility of regrinding and re-using the fused flux was considered practical in view of the fact that all welding passes, after the first, were depositing perfectly clean metal which had just been cleaned by the arc. A small hammer mill was installed directly in a chute discharging the fused flux from the overhead hopper. The reground flux discharged directly from the mill back to the lower hopper. To protect the mill it was found necessary to install an electromagnet above the feed chute ahead of the mill to remove tramp iron. Due to the abrasive action of the flux, it was necessary to prevent almost daily breakdowns due to wear. Therefore, the sizing screen in the mill was removed and lined completely with abrasive resisting material. The rotational speed of the hammers was greatly reduced and a small circulating load of oversize is carried in the mill circuit with better results.

With re-used flux it was necessary to reduce welding currents about 50 amp. to 650 maximum instead of 700 amp. maximum to prevent flux from sticking. Also, carbon content of deposits dropped about 0.08%. It was felt that this reduction in carbon and welding current is economical in view of the substantial savings in welding flux.

Flux consumption still is a factor with some being spilled on the floor, some blown out the vent by the fan and some apparently being taken up by the weld. Table 2 shows the result of recent checks of flux consumption.

Table 2—Materials Per Set

Process	Size Wheel	Deposit, Lb.	Wire Burned, Lb.	Lincolnweld Fused, Lb.	660 Flux Lost, Lb.
Open arc	Av.	120	175	None	None
Submerged arc	Av.	121	130	215	15

When the first shielded automatic arc head was placed in operation welding was done with reverse polarity (electrode positive, work negative) as this was the standard procedure adopted in other plants for seam welding with the flux-shielded metallic arc process. After the installation of the second automatic welding head experiments were conducted operating the units on straight polarity (electrode negative, work positive) and it was found that at a 600-amp. current setting, burn-off rate and, thus, deposition rate, was increased 20%. In addition, the carbon content in the deposit was increased approximately 0.10% by the change in polarity, and the hardness of the deposit stepped up from 32–34 Shore to 36–38 Shore. As a result of these tests the standard procedure was altered to specify welding with straight polarity.

The second shielded arc head was installed recently at which time the fixture was improved to provide powered traverse of the heads with readily adjustable control by the operator. The operators are becoming very skilled in building up to template contours and diameters as shown in Fig. 4. One set of wheels has been put in service experimentally without any machining and several sets with only the flanges machined are in use.

So far nothing has been said about wearing and traction qualities which, if improved as expected, will realize a considerable savings in lost production or in stand-by equipment investment through reduced motor outage, disassembly and assembly time. The shielded arc deposit as shown in Table 3 is estimated to give a better life than the original, or bare arc rebuilt wheels, because of the properties imparted by density, homogeneity and the manganese and silicon contents.

Table 3—Analyses (Standard Procedure—Average)

Process	Carbon	Manganese	Silicon	Hardness-Shore
New wheels	0.50–0.80	0.55–0.85	0.15–0.30	42–44
Wire	0.55–0.65	0.55–0.70	0.15–0.25	...
Open arc	0.33–0.38	0.65–0.75	Not analyzed	32–36
Lincolnweld	0.35–0.40	1.20–1.30	0.40–0.45	36–40

Wheels rebuilt with the open arc came back worn showing hardness 55–65 Shore on the faces and flanges and were frequently spalled. Of the three sets of wheels which are the only shielded arc rebuilt wheels back to date for a second rebuilding, only one shows spalls

and that is in open arc deposits which were not removed prior to the shielded arc rebuilding. The shielded arc deposit shows almost no increase in hardness which probably indicates better traction and better wearing qualities.

The possibility of further improving traction and wearing qualities through further alloying either with alloy wire or through the flux is under consideration but no conclusive data are available at present other than the fact that higher carbon wire does not weld as well and is more difficult to machine.

In our experience it has been necessary to rebuild a set of wheels on an average of every 19 mo. of service. With the shielded metallic-arc process of rebuilding, wheels are being welded and turned at a cost less than that of the open arc process and are sent out with a dense, homogeneous deposit which will not spall and which shows much less tendency toward breakage. Main savings from the process are expected by realizing a longer life in service and through the flexibility offered by the process in allowing more drastic changes in wire and, consequently, the weld deposit characteristics.

A Guide for Cutting Small Circles

A Handy Device for the Shop

By H. P. Martin*

SMOOTH, true cuts on circles or circular segments of small radius can be made easily with a hand-operated guiding device for the blowpipe. Figures 1 and 2 show such a device, which was designed for use with an Oxweld C-48 machine-cutting blowpipe. This guide was made especially for cutting rounded ends on structural steel pieces used in the manufacture of ice-chipping machines. Since the guide was designed for a specific purpose, only a small allowance was made for adjustments in radius. By varying the dimensions shown in the drawing, Fig. 3, however, the guide can be adapted to the needs of almost any job calling for small circles. It can be easily fabricated from stock materials. Many shops will find it useful for doing work that usually requires larger, more elaborate equipment.

* Service Engineer, The Linde Air Products Co., Memphis, Tenn.

Fig. 1—This Guiding Device for Cutting Small Circles or Circular Segments Is Being Used to Cut Rounded Ends on Steel Parts

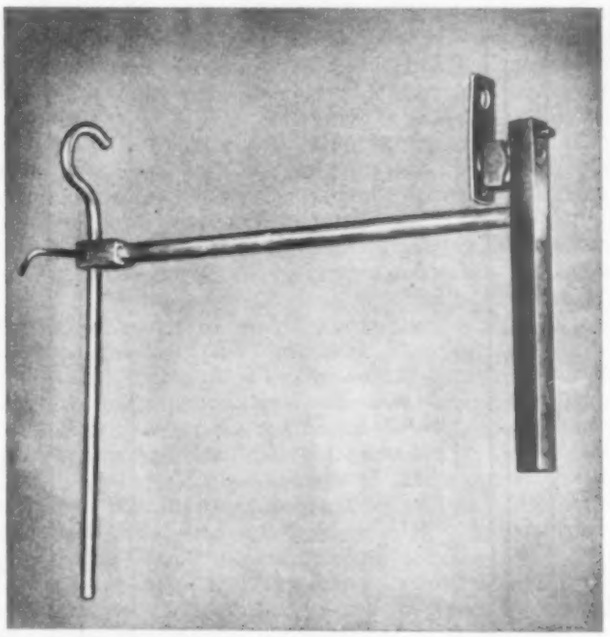


Fig. 2—The Guide Can Be Easily Fabricated in the Average Shop. Smooth Accurate Cuts Can Be Made With It After a Little Practice

Assembly of the Guide

The parts of this device are made according to the specifications shown in Fig. 3. The nozzle supporting bar is fastened to the base, as shown in the illustrations, by means of a capscrew and washer. Then the vertical member is bronze welded to the top of the base $2^1/_2$ in. from the end. The blowpipe hook is inserted through the hole in the block at the top of the vertical member and, when the blowpipe is properly positioned, is secured with an Allen setscrew.

The radius adjustment is limited by the distance between the $^1/_4$-in. slot and the $^5/_8$-in. hole in the nozzle-supporting bar. The guide can be adapted to cutting circles of smaller or larger radius by decreasing or increasing the length of this bar from the $3^1/_4$-in. length specified in the drawing.

Operation

This guiding device is simple to operate. First, the center of the circle or segment to be cut is located on the plate and drilled to accommodate the pivot pin on the base of the guide. The plate is clamped or secured somewhat as shown in Fig. 1. The pivot pin is inserted in the center hole and the blowpipe is positioned in the guide and carefully adjusted for the desired radius. The setscrew on the hook and the capscrew on the base are then tightened. Once the cut is started, the operator needs only to move the assembly around the pivot, taking care to maintain the correct cutting speed. Smooth, accurate cuts can be easily made after a little practice with this device.

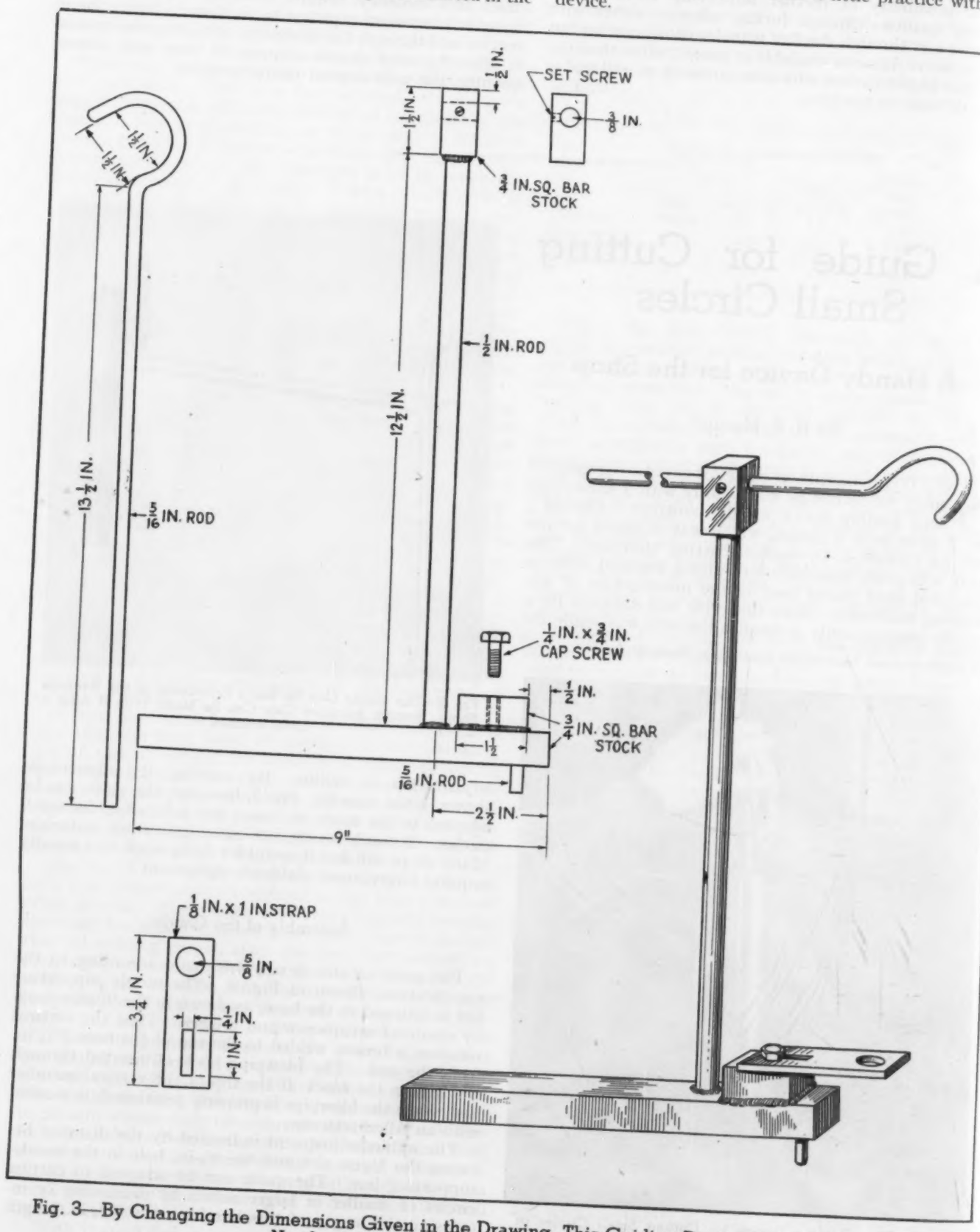


Fig. 3—By Changing the Dimensions Given in the Drawing, This Guiding Device Can Be Adapted to the Needs of Almost Any Job Calling for Small Circles

Inspection of Welded Construction*

By A. E. Poole†

In its extensive program of welded construction during the war years, the Bureau of Yards and Docks of the Navy Dept. soon established the fact that good inspection during building was of ever increasing importance, having a direct bearing on the cost of work, expediency of accomplishment and the quality of the final product. Contrary to a sometimes mistaken impression, good inspection in the fabricating shop as well as in the field decreased the cost of work, accelerated completion and resulted in a far superior product. This was found to be especially true where the inspection requirements regarding fit-up of all members, whether in subassembly or final assembly was maintained to an exacting degree.

Welding involves more sciences than practically any known industrial manufacturing process, and has therefore been made to appear rather mysterious. However, when a good welded structure is designed, the sciences are considered and allowances made for the changes which take place and the forces which are brought about during welding.

It is practically impossible for the average field inspector to have knowledge of metallurgy, physics, chemistry and the stresses which are involved. Inasmuch as the designer has taken these into consideration, it is necessary for those in charge to stress to the field inspectors the necessity for closely following the work, without deviation from the plans and specifications unless approved by those charged with the responsibility of design. Strict adherence to the approved plans and specifications will minimize difficulties.

It is necessary for the inspector in the field to have or be provided with, and to be thoroughly familiar with all reference drawings and specifications, approved or referred sequences, data relating to inspection laboratories, reports of contractors' and subcontractors' approved materials, reports of tests and other pertinent information so far as it is available.

Many of the difficulties with welded construction cannot be attributed to the use of welding as compared to riveting, but rather to the quality of materials and workmanship involved in shop fabrication, the method of field assembly and fitting up of the members. In riveted construction the progress of the work is generally determined by the amount of steel erected. It is necessary to stress the fact that this does not apply to welded construction and is actually detrimental because if steel is erected too far in advance of welding operation, the weight of the materials does not allow freedom of movement (shrinkage) of the members being welded. Excessive weight can also create slight deformities in the unwelded members and upon completion of the welding, the stresses caused by the deformations will be locked up in the structure. In welded construction completion is dependent on the speed of welding rather than on the erection of steel. The completion date will be determined by the number of welders available that can be expeditiously and economically utilized. The erection of steel too far in advance of welding will result in an inert mass so restrained as to restrict movement. Freedom of movement is essential to avoid locking undesirable stresses into the structure due to the normal expansion and contraction which is present when the welds are made. The sequence and method of assembly and erection have an important bearing on this factor and must be thoroughly considered prior to and during construction.

If freedom of movement is present, to a certain extent the structure will be alive while welding is in progress. Dimensional changes and variations in levelness will take place. A thorough system of survey control is therefore essential in order to provide a running check on the effects of welding. All variations, from line and grade, even though slight, must be thoroughly analyzed and the method of erection and the sequence of welding revised to alleviate and correct the condition. Final variations and irregularities are an indication of incorrect procedure, and slight variations, if permitted to accumulate during assembly without appropriate action, will result in future difficulties impossible to correct or at least will seriously delay the work and final completion.

To sum up conditions three factors are essential if the work is to be accomplished expeditiously and economically with a minimum of trouble: i.e. (*a*) a thorough and adequate design, (*b*) good construction methods and (*c*) thorough inspection.

It is the owner's responsibility to see that an inspection procedure, or at least that minimum inspection requirements are furnished to the field for use as a guide on which to predicate the organization necessary to see that the job requirements are complied with. Local conditions and the type structure involved must be thoroughly analyzed before the actual start of construction and should be considered in developing the field organization. Required forms and reports must be maintained accurately and submitted for the use of the engineer or designer where required. In this way, the controlling agency will be in a position to assist and to advise wherever necessary. This is extremely important in view of the many difficulties which may arise if the work is not accomplished in accordance with pertinent job directives. Welding, and in particular, electric arc welding is really not mysterious and does not require specialized knowledge if instructions are carefully followed.

Specification requirements for large or important projects will be detailed and specific; for smaller or less important projects, less exacting. The extent of deviation from rigid inspection must be determined by existing conditions but all forms and reports as called for should be executed. The type and purpose of the structure should be given reasonable consideration in the application of the requirements of these instructions.

The policy of the Bureau of Yards and Docks during

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* This article based on the Introduction of the U. S. Navy Dept., Bureau of Yards and Docks Welding Inspection and Test Procedure for Welded Structures published in August 1945.

† Commander, CEC, USNR, Welding Consultant, Construction Dept., Bureau of Yards and Docks.

war construction was to follow rigid inspection, yet consistent with the war effort and the urgency of early requirements. The greater percentage of welded construction by the Bureau was not of the expendable type, but rather developed to furnish service over a considerable span of time. This policy of good and thorough inspection has been proved by the fact that to this date, there have been practically no failures of its welded construction of any consequence, even though the greater portion has been in use for a considerable period of time and much of the equipment subject to enemy action or a maximum of the rigors of war.

A National Spokesman for Engineers

By A. B. Stickney*

THERE are upwards of 200,000 engineers in this country sufficiently interested in engineering as a profession to have joined a society, but not over 10% of them belong to any one society. There is a widely felt need of an over-all organization of all the societies to act as spokesman for all engineers on matters of common concern. On a local basis over 100,000 engineers in 35 metropolitan areas have organized themselves into Local Councils, and are doing an effective job of intersocietal cooperation within their sphere of activity. In the last few years much has been said and written about a similar organization on a national scale. Everybody wants it—everybody is talking about it—it's in the air—it's coming—it's inevitable. While it is no longer necessary to talk about why or whether there should be such an organization, there is no such unanimity about what it should be like. This paper outlines a proposed organization by answering four questions—who; how; what; and who will pay for it.

First, *who?* It should be built on the foundation that the American Standards Association has so effectively employed, that anyone having a legitimate interest has an inherent right to participate. There are five types of organization which have that legitimate interest. They are:

1. The so-called Founder Societies—Civil, Electrical, Mechanical, Mining and Metallurgical, and, included in recent years, Chemical Engineers. These societies have large memberships, and each embraces a whole field of engineering. Together they have perhaps 40% of the engineers of the country on their rolls.

2. The specialized National Societies. The Agricultural, Automotive, Heating and Ventilating, Illuminating, Radio, Refrigerating, Tool and a host of other engineers, all have their own societies. While some of the members of these societies are also members of Founder Societies, there is a general disinclination to belong to more than one society, and a great many of them have dropped their Founder Society memberships because only an occasional paper or article was of significance to them, whereas in their specialized society a large part of the papers and other activities is of interest, and the closer contacts in the smaller groups are more stimulating. Beyond that, these societies generally have an associate grade of membership for the men who would not be eligible under the stricter rules of the Founder Societies, but who none-the-less practice engineering, and these men must be included in any organization undertaking to speak for engineers as a whole. Collectively, these specialized societies have a larger membership than the Founder Societies.

3. Local specialized groups, similar to the specialized national societies but not organized on a national scale. There are a number of such organizations in the various Local Councils, and they undoubtedly exist in considerable numbers in all the larger metropolitan areas.

4. The Local Councils, which are composed of the Local Sections of National Societies and of Local Groups, so that membership is by virtue of membership in some other organization. A survey of the 35 then in existence was published by the Cincinnati Council last April. This survey, by Frank Sanford, past-president of the Cincinnati Council, has been widely publicized, and is available on request, so that no elaboration is required here.

5. The local Engineering Societies or Engineers' Clubs, which have individual membership but which cut across the field and have members with all varieties of specialties. Probably all cities of over 100,000, and a great many smaller cities, have them, and in a great many cities they are the only local organization of engineers, and provide the only direct contact a great many engineers have with others of their profession outside of business hours.

Trade Associations or organizations having predominantly company memberships should definitely not be included, since the object is to represent the interests of engineers as individuals. But the line must be carefully drawn here. Such societies as A.S.T.M. with a combination of company and individual memberships should certainly not be excluded, at least as far as their individual memberships are concerned.

Whether technologists in other fields than engineering should be included is a moot point. Chemists, physicists, biologists, food technologists and the like are in several of the Local Councils. Probably they would not want to be included in a national engineering organization, but that is something for them to decide for themselves.

Second, *how?* A governing body for a national organization would be formed by having each member body select one representative for a period of three years, with the larger organizations having more than one representative, say on a basis of major fractions of 5000. Thus a society or council with over 7500 members would have a second representative, one with over 12,500 a third, one with over 17,500 a fourth, and so on. Confining these representatives to men who have held general elective office, such as past-presidents, past-chairmen, past-vice-presidents, etc., would assure experienced responsible talent. Terms would be staggered so that one-third were elected each year. These men, and there might be a couple of hundred of them, would form the National Council. It would elect its own officers and the members of standing committees. The Council would meet twice a year, and between times

* Past-President and Chairman, Committee on Relations with Other Organizations, American Society of Refrigerating Engineers.

an Executive Committee composed of the officers and the chairmen of all standing committees would give effect to the decisions of Council. There would, of course, be a paid secretary and staff.

In addition to the usual committees necessary to the carrying on of the business of the organization—Executive, Finance, Constitution and By-Laws, Nominating, Membership, etc.—there would be a standing committee in charge of each activity the Council undertook. Additional activities could be undertaken, and additional standing committees formed to supervise them, by say two-thirds vote of the entire Council membership at two successive meetings, which would mean that any controversial points could be discussed by the governing bodies of the member organizations, and their representatives instructed, before a final vote was taken. However, the president, with the approval of the Executive Committee, could appoint special committees having a limited term and advisory or temporary executive powers.

Third, and most important, *what?* This is the point where most of the disagreement occurs. There are many things the National Council might concern itself with, and some of them will be enumerated shortly. But what do the majority of engineers—the men the Council will be spokesman for—want? Nobody knows or can know. The issues have never been laid before them—there is no mechanism for doing it. And right there is the answer to the question. *Create the mechanism, lay the issues before them, and find out what they want!* That's all that is necessary to start with, and it's a big job. When the wants are known, the mechanism will be at hand to do something about them, with the safeguard to prevent going off the deep end that there must be a two-thirds vote at two successive Council Meetings, 6 mo. apart. After a few years there will be a variety of activities, but no one can predict today just what they will be. There are various cooperative activities going on today—to mention just one, the Engineers Council for Professional Development—and if it is deemed desirable, these activities can be blanketed in as standing committees without any break in the continuity of their work.

What is the mechanism for finding out what is wanted? Start a magazine which will go to each of the individual members of each of the member organizations, by virtue of that membership, in addition to the publications of his own organization. Discuss the issues—present both sides—and let the membership of the various societies tell their representatives what they want.

The magazine would be divided into four main parts. The first part would be the policy articles—the social and economic status of engineers, licensing, collective bargaining, engineering education, pending legislation, standardization, sponsorship of research, patent policy, economic theory, national and international affairs, and similar subjects. Perhaps only 10% will read the articles on any given subject, but 10% of all engineers is in itself a large audience, and the rest will be proud to have the articles available, even if they don't read them. A magazine with the circulation we are talking about, going to all engineers, will be unique. There is nothing like it today, and it could command talent that none of the individual societies can touch. It will make it possible for the first time to lay before the entire profession the best thinking on both sides of issues of concern to engineers.

The second part of the magazine would be informative articles on engineering matters of general interest. It would be written from the standpoint of telling engineers what is going on in the engineering world outside of their own fields of specialization. Such things as regional planning; development, utilization and conservation of natural resources; flood control, city planning, superhighway system integration, new railway equipment, developments in radio, automotive engineering, frozen foods, new engineering materials and methods of their utilization, and the like, and also the technical matters which capture the public imagination from time to time and which the engineer feels he should know more about, such as nuclear physics and radar last year, would be discussed by authorities, but in a style which assumes only the basic engineering knowledge and viewpoint we all have, and popularizes the subject from there on. This type of article would have a tremendous popular appeal and a broadening influence on engineers' viewpoints and fields of knowledge which might well prove the most valuable thing to come out of the entire program.

The third part of the magazine would be the news of the organization and of the member organizations, and of engineers individually. It would include a series of writeups of the member societies and councils, cross-sectional studies of how various societies solve organizational problems common to all societies, news of elections, meetings, activities of general interest, etc. News of individual engineers would be primarily from the standpoint of activities of interest to all engineers, or of activities outside the technical field, such as in civic affairs. A very important part of this section would be a forum in which the individual was encouraged to express himself on the issues being discussed or bring up new issues for discussion. Editors say this is a hard department to run—if so, its success would be a measure of the editor.

The fourth part of the magazine would be a combined index of the technical parts of the publications of all member societies, and perhaps of commercial technical journals as well, with the articles classified as to type (new contribution, survey, polemic, etc.) and a brief description where the content is not evident from the title, so that the individual engineer could find out about articles of interest to him which appear in journals he does not normally see. Means would have to be provided for him to see the articles after he found out about them. This section would also carry book reviews and notices of publications of general interest, such as indices of standards and the like.

Finally, *who is going to pay for it?* Let each member group pay a $1.00 subscription to the magazine for each individual member. Where a man is a member of more than one group, split the dollar. Where membership in one group is by virtue of membership in another group which is already in the National Council, there would be no charge. Beyond that, the advertisers will pay for it. The magazine will be an advertising medium with a circulation from both the quantitative and qualitative standpoints which will be very attractive, and after it is once going, the magazine should not only pay its own way but should yield a profit which will support other activities of the Council as they are authorized.

In conclusion, the Council of the American Society of Refrigerating Engineers has authorized the writer to sit on an Organizing Committee to formulate a specific proposal and invite attendance at a general organization meeting to give effect to such a scheme, and it has made an appropriation to help defray the expenses of such a committee. A number of other groups have been invited to do likewise, and it is quite possible that such a committee will be functioning within the next few months. The thought is to keep it small enough to function efficiently, and yet diverse enough so that its proposal will be generally acceptable, and will not represent domination by any group.

Analysis of Certification of Electric Arc Operators for Work on Navy Contracts at Private Plants

By Lt. Comdr. V. M. Alexieff, USNR

ALL electric arc welding, at privately owned plants engaged in construction of Naval material, must be performed by a Navy Certified Operator. Almost without exception every Navy contract states that before being permitted to perform any production work, each welding operator shall pass a required test. The tests are given by the contractor who directs and supervises the testing of welding operators and bears all the expense of conducting those tests. The welding and testing must be done in the presence of a Naval inspector.

To analyze the general condition of war-trained welding operators, a series of records were kept throughout 1944 in a medium size war plant. This plant was located

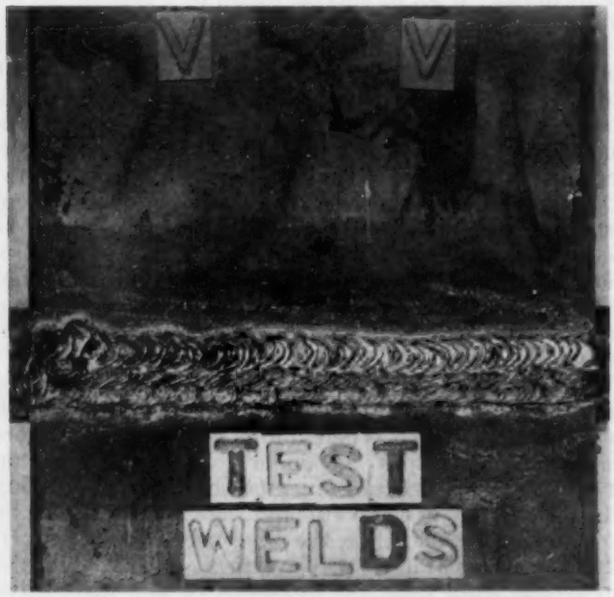

Fig. 1—Photograph of an "Average" Test Plate Welded in Vertical Position, Mild Steel

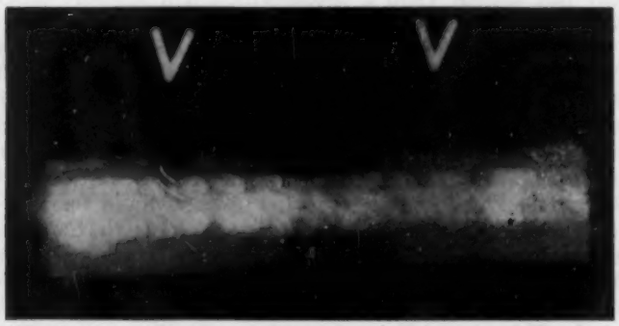

Fig. 2—X-ray Photograph of an "Average" Test Plate Welded in Vertical Position, Mild Steel

Fig. 3—Photograph of an "Average" Test Plate Welded in Overhead Position, Mild Steel

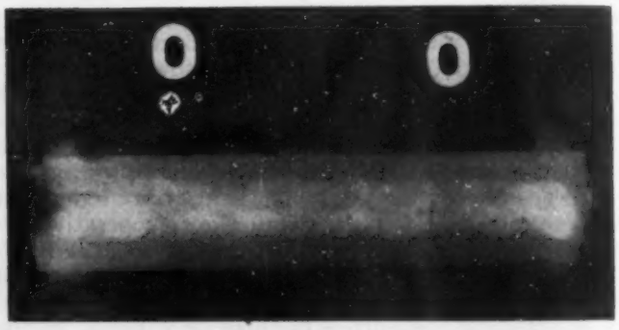

Fig. 4—X-ray Photograph of an "Average" Test Plate Welded in Overhead Position, Mild Steel

Fig. 5—Photograph of an "Average" Test Plate Welded in Vertical Position, Alloy Steel

Fig. 6—X-ray Photograph of an "Average" Test Plate Welded in Vertical Position, Alloy Steel

in a Group II West Coast City of about 90,000 people, and manufactured a large welded structure (a landing craft). All welding was done on metal less than $^3/_4$ in. in thickness, primarily mild steel, but with some portions of alloy steel. The average employment in 1944 was about 1200, of which approximately 14% were welding operators. Those were recruited from three principal sources: (*a*) other war industries (primarily shipyards); (*b*) private welding schools; and (*c*) company-city sponsored welding classes. All prospective welders were given the so-called Test No. 1, and on successfully passing it were qualified as Navy Certified Welders, and hired by the contractor at journeyman's wages.

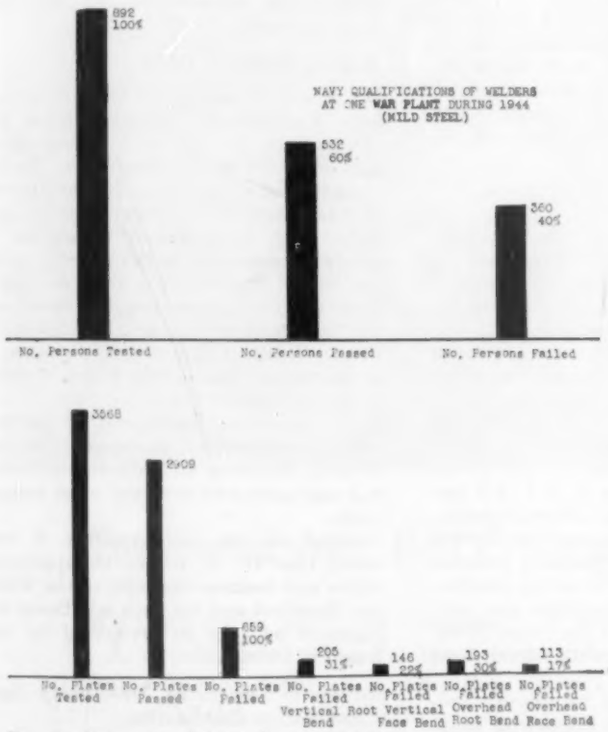

Fig. 7—Navy Qualifications of Welders at One War Plant During 1944, Mild Steel

Test No. 1, which is a general test, consists of welding together two $^3/_8$-in. thick mild steel plates (6 x 5 in.) using a $^5/_{32}$-in. rod. The plates were prepared for a butt "V" joint (60°) weld. One set was welded in a vertical position while the other set was welded in an overhead position. Each set of two welded plates was then trimmed, machined, cut in two and bent double over a special jig. One-half was given the "root bend," while the other half the "face-bend." Of the 892 persons tested in 1944, 532 passed and 360 failed. Of the 3568 plates bent in 1944, 2909 passed and 659 failed. Failure of the 659 plates was as follows: 205 failed in vertical root bend; 145 in vertical face bend; 193 in overhead root bend; and 113 in overhead face bend.

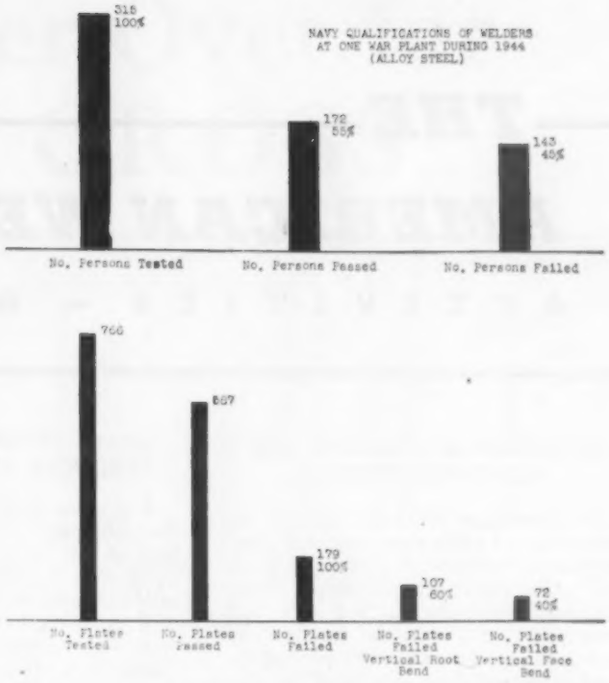

Fig. 8—Navy Qualifications of Welders at One War Plant During 1944, Alloy Steel

During the spring of 1944, alloy steel was incorporated in certain portions of the structure and welding operators assigned to this work were further tested. In addition to passing the above-mentioned Test No. 1, they were required to pass a modified Test No. 1 using alloy-steel plates and alloy-steel electrodes. Only welding in a vertical position was required. Of the 315 persons tested in 1944, 172 passed and 143 failed. Of the 766 plates bent in 1944, 587 passed and 179 failed. Failure of the 179 plates was as follows: 107 failed in vertical root bend and 72 in vertical face bend.

Although the tests given did not necessarily represent the production procedure, they did demonstrate the operators' ability to weld correctly. The above results specifically showed that failure in root bend predominated, and that on the average, two plates failed for every person who did not qualify as a Navy Certified Welder. This information was found helpful to supervisors for the best utilization of man power.

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THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

RECOMMENDED PRACTICES FOR RESISTANCE WELDING

The AMERICAN WELDING SOCIETY has just published a new report entitled "Recommended Practices for Resistance Welding." This report is a compilation of recommended practices for the spot and seam welding of low-carbon, stainless and hardenable steels, nickel, Monel and inconel; the projection welding of low-carbon and stainless steels; flash-butt welding low and medium forging strength steels; and standard methods for testing resistance welds. Each recommended practice comprises a table of machine settings for current, voltage, time, pressure and other factors, which will produce welds of specified strength in various thicknesses of materials. Explanatory text on each of the factors is included. The section on standard methods for testing resistance welds covers tests for tensile properties, shear strength, impact strength, fatigue properties and hardness. It includes a complete description of the test specimens, the equipment to be used and the procedure to be followed. Also included is a section on control of weld quality by statistical methods.

These Recommended Practices were prepared by the A.W.S. Resistance Welding Committee, and are being issued at this time to meet the immediate need for the data they contain. At the same time the Committee is continuing its studies of resistance welding additional thicknesses and other materials, including copper and copper steels.

All of the Recommended Practices described above are contained in a 48-page bulletin, priced at 50 cents per copy. Copies of the bulletin or further information may be obtained from the AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y.

1946 A.W.S. DIRECTORY

In order to conserve paper the new 1946 A.W.S. Membership Directory, now available, will be sent only to those requesting a copy. There is no charge to members of the SOCIETY. Address request to: AMERICAN WELDING SOCIETY, 33 West 39th St., New York 18, N. Y.

BOARD OF DIRECTORS MEETING AMERICAN WELDING SOCIETY

A meeting of the Board of Directors of the AMERICAN WELDING SOCIETY was held at the Hotel Cleveland, Cleveland, Ohio, Feb. 6, 1946. The meeting was called to order by President Hess at 9:45 A.M. with the following present. *Members:* C. A. Adams, D. Arnott, R. W. Clark, J. H. Deppeler, O. B. J. Fraser, H. O. Hill, C. H. Jennings, A. B. Kinzel, J. F. Lincoln, R. E. McFarland, H. W. Pierce, E. R. Seabloom, G. N. Sieger, W. G. Theisinger, C. M. Underwood, A. C. Weigel and B. L. Wise. *Guests:* J. J. Crowe and E. V. David. *Staff:* M. M. Kelly and W. Spraragen.

By-Law Amendments

Recommendations of the By-Laws Committee—to take care of vacancy occurring in nominees for officers; to legalize the holding of an Annual Meeting of the SOCIETY at a time other than that provided for in the By-Laws; to provide for the bonding of officers and staff members handling monies of the SOCIETY; and to prevent submittal of By-Law amendments to the membership during the months of May, June, July and August—which were recorded in Appendices A, A-1, A-2 and A-3 attached to agenda of this meeting, were reviewed. It was voted to approve for publication in THE WELDING JOURNAL and later submittal to the voting membership for adoption, the addition and revisions of the By-Laws. (EDITORIAL NOTE: These were published in the March issue of the JOURNAL.)

It was further voted to approve Proposal 1 of the By-Laws Committee in respect to the Annual Meeting, namely, that the Annual Meeting be held in New York in October, as specified in the By-Laws, and without transaction of business, adjourn the meeting immediately to Atlantic City, setting the time and date at which the adjourned meeting will be reassembled.

It was further voted that announcement of the October meeting, sent to the A.W.S. membership, contain notification that the Annual Meeting to be held in October will be adjourned without transaction of any business and is to be reassembled in Atlantic City on a date in November to be specified.

Finances

Report on financial operations of the SOCIETY for the first quarter of the fiscal year ended December 31, 1945, was presented by Chairman Fraser. Although the SOCIETY continues to show an excess of income over expenses the amount was not so large as in the previous year.

On recommendation of the Treasurer, the JOURNAL budget expense for the current year was increased by $1820 to permit of the employment of an additional stenographic assistant to THE WELDING JOURNAL staff.

Welding Handbook Editor

Report containing the *Welding Handbook* Committee's recommendation for employment of a *Welding Handbook* editor was presented by Mr. Boardman. In explanation of part-time service mentioned in this report, it was stated that the Special A.W.S. Organization Committee is giving consideration to the use of a small portion of the Editor's time on other Society activities—Section visitation and the like. Such arrangement is satisfactory to the *Handbook* Committee, providing a proportionate share of the Editor's salary is charged against this other activity, and further providing it is understood that the editing and business management of the *Welding Handbook* and educational books will take precedent over any other assignment.

Based on this understanding, it was voted that H. O. Klinke be appointed editor and business manager of the *Welding Handbook* and for such additional assignment as may be prescribed by the Board of Directors.

Returns to Sections on Membership Dues and Section Coordination

As recorded, at the December 6th Directors' meeting a Special Committee was appointed with scope to study and offer recommendations to the Board of Directors on recommendation of Puget Sound Section for an amendment of the By-Laws to provide for an increase in returns to Sections on dues collected; and further, to investigate machinery for acting on and reporting to the Board of Directors on irregularities in the operations of A.W.S. sections. The Section Advisory Committee Chairman was named Chairman of this Special Committee. An interim report was made to the Board of Directors.

In the ensuing discussion, there was no unanimity of opinion as to the Sections' need for additional financial support. There was a feeling on the part of some

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that the smaller Sections need additional financial support to conduct worth-while meetings and they believed possibly, the suggestion of the Special Committee for setting a minimum annual refund would meet this need. In this regard, point was made that members of other technical socities pay a local membership fee to help meet the Section expenses. A further point made was that the incentive for getting members is lost when Sections with small memberships are subsidized. Representatives of the larger Sections suggested an alternative of raising the flat sum paid annually to Sections from $100 to $150 or $175. It was generally agreed that the life of a Section depends upon properly arranged and conducted meetings with good speakers. By some, it was believed that National Headquarters ought to render greater assistance, particularly in outlying districts, in providing Sections with speakers, in persuading the Sections to have their season's meetings arranged and programs ready for distribution in advance of the opening of the season, and in guiding the Sections in properly arranging their meetings. Appeal was made for the assistance of National Officers, Directors and manufacturing interests in obtaining good speakers. The thought was expressed that the right kind of leadership in the Sections would solve most of the Sections' problems. It was believed also that closer contact than now exists between the Sections, the officers and staff would alleviate some of the present difficulties. It was recommended that Sections in outlying districts be encouraged to confer on meeting dates and endeavor to arrange time schedules that will enable a speaker to cover a group of Sections on one trip.

Another suggested solution was the appointment of a committee with scope to render assistance when required, to Sections in obtaining good speakers, and with funds at its disposal to use with discretion in meeting travel expenses of the speakers. It was also suggested that a study be made of the minimum number of members required to form a Section, as perhaps this figure is too low to enable a Section to function successfully.

After deliberation, it was voted to adopt suggestions of the Special Committee for handling delinquent Sections, recorded below.

Check at the end of each quarter regarding number of members, number of meetings held and other activities. Send a letter to the Secretary of delinquent sections, commenting on delinquencies and inquiring as to reason and further possibilities. Send copy of letter to District Vice-President, President and Membership Committee Chairman.

At the end of six months, make a similar check. Write delinquents, calling attention to By-Law requirements and necessity for discontinuance of refunds unless the Section will meet By-Law requirements. Send copy to District Vice-President with a request for his comments and advice, copy also to President and Membership Committee Chairman.

At the end of seven months of delinquency stop making refunds and bring the matter to the attention of the Board of Directors for their consideration.

Further, it was voted to refer back to the Special Committee for further study the matter of additional support to A.W.S. Sections, with request that the Committee take into consideration suggestions offered at this meeting, and that it confer with the Finance Committee in arriving at an equitable conclusion that can be submitted to the Board of Directors at its next meeting.

Further, it was voted that the Puget Sound Section be informed that because of the need for further study and consideration of the findings of the Special Committee on Section refunds, and because of ramifications, resulting from discussion of the report at the Board meeting, no extra money can be appropriated at this time for the Puget Sound Section for its expanded program.

Program of American Welding Society Activity

It was recalled at the September 1945 Directors' meeting J. F. Lincoln offered to prepare for the Board of Directors a program of activity of interest to the A.W.S. membership and President Weigel accepted this offer with the understanding that such program might or might not be acceptable to the Board. Acting on this authorization, Mr. Lincoln wrote to the Sections of the Society. In presenting his report on program of activities of interest to A.W.S. membership Mr. Lincoln

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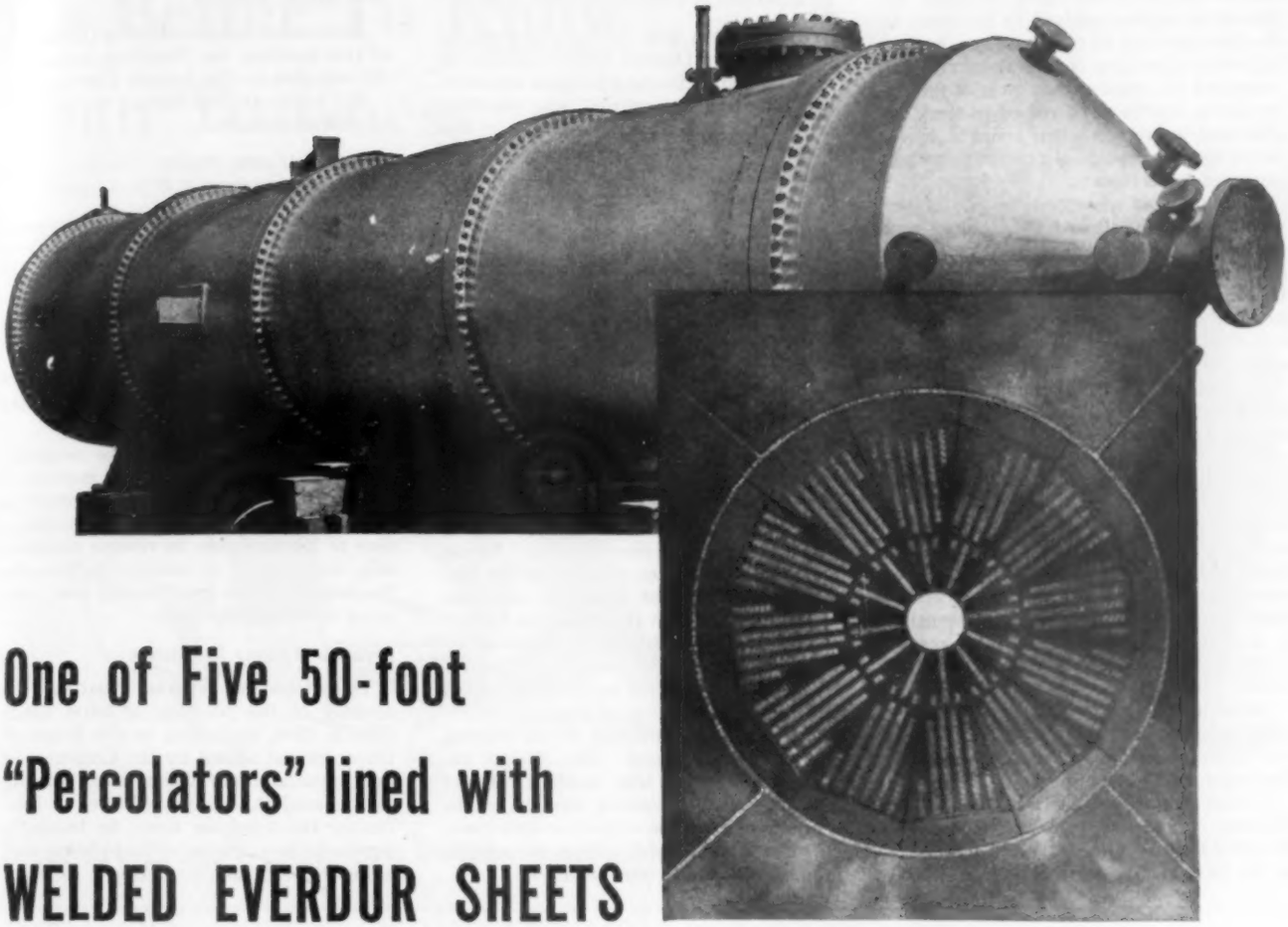

One of Five 50-foot "Percolators" lined with WELDED EVERDUR SHEETS

One of the five large "percolators." A total of 66,000 lb. of Everdur sheet and tube was used in fabricating the complete plant. Note the slotted Everdur screens welded into conical section.

THIS LARGE VESSEL is part of a plant designed and engineered by The Vulcan Copper and Supply Company, Cincinnati, Ohio, to produce 190 proof ethyl alcohol from wood waste. Among the numerous equipment items especially designed for this plant were five steel percolators 96″ I.D. x 50′3″ high, which were fabricated by the Southwest Welding and Mfg. Company of Alhambra, California. Everdur* Metal, because of its high strength, corrosion resistance and weldability was used for the linings, in sheets .134″ thick.

Welds in the Everdur lining had to develop approximately 85% tensile strength of the annealed sheets, with elongation of at least 60% on free bend test. With the assistance of a welding engineer from The American Brass Company, a carbon arc welding procedure, using Everdur rods, was established, developing 98.5% tensile strength and 64% elongation. Two operators thus instructed were qualified at 87.5% and 95% tensile strength, and 72% and 76% elongation.

This method of design and construction resulted in an increased volume of wood waste treated in each charge which, together with various operational changes, promises a daily output *several times greater than* the previous process.

*Reg. U. S. Pat. Off.

ANACONDA

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WELDING RODS

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

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stated that it represented opinions expressed in replies received to his letter to the Sections and in conversations he had had with members of the SOCIETY. He expressed the opinion that most of the objection to the SOCIETY voiced in these replies and in conversations could be eliminated by the adoption of a program such as proposed in his report.

Thought was advanced by one of the members of the Board that before any change in organization is made it is well first for the Board to review and become thoroughly familiar with present organizational setup and then to make sure that any change proposed will meet the wishes of the membership.

In transmitting Mr. Lincoln's report to the Directors and to the Special Committee on A.W.S. organization for study and consideration it was deemed advisable that it be accompanied by copies of replies received from the Sections. Mr. Lincoln was asked, therefore, to submit such copies. Since he stated it was not possible to comply with this request because of the wish of some of the Sections that the information be kept confidential, it was agreed that Mr. Lincoln's report would have to be considered as his personal views.

Accordingly, it was voted to accept the Lincoln report and to refer it to the Special Committee on A.W.S. Organization for study and consideration.

It was further agreed that copy of the Lincoln report be transmitted to the Board of Directors for study and discussion at the next meeting of the Board.

Disbandment of Inactive Sections A.W.S.

Report on A.W.S. Sections and recommendations of District Vice-Presidents for disbandment of inactive Sections not meeting by-law requirements, was carefully considered and after deliberation it was voted to approve the recommendation of the District Vice-Presidents for the disbandment of the following Sections:

District 1—Canal Zone
District 3—Brunswick, Ga.
Mobile, Ala.
Savannah, Ga.
District 4—Canton
District 5—Lake Shore
Omaha
Quad Cities

Reduced membership and inactivity of the two Hawaiian Sections, one in Honolulu and the other Pearl Harbor, of Atlanta, Ga., and of those in shipbuilding centers, were given consideration. It was believed desirable to suggest to the Hawaiian Sections that they now combine. It was reported that Headquarters had received offer of assistance in reviving interest in Atlanta, Ga., from a representative of one of the large welding companies and the Vice-President of that district requested that disbandment of the Atlanta Section be postponed. Mr. Weigel expressed the belief that welding interest in Cuba warrants looking into the establishment of a Section of the SOCIETY there. He offered to furnish names of possible promoters of such a movement.

1945 Miller Medalist

As recorded inAppendix E of the agenda of this meeting, the President announced the selection by the Awards Committee of J. F. Lincoln as 1945 Samuel Wylie Miller Memorial Medalist.

Report of Making Bankers Trust Co. Custodian Depository of A.W.S. Securities

The recommendation of the Permanent Funds Committee that the Bankers Trust Co. be made custodian depository of A.W.S. securities was approved and resolutions required by the Bankers Trust Co. to put this into effect was adopted.

Establishment of Procedure for Reinstatement to A.W.S. Membership of Returning Veterans

The Board ruled that the returning veteran be welcomed back as a member of the SOCIETY; that his dues be remitted for the first three months following notification of his intension to resume membership, and that he be invoiced for dues for the balance of the membership year, prorated on a monthly basis.

Separate Welding Exposition

The President reported that at the opening of this meeting, a letter dated Feb. 5, 1946, addressed to the Board of Directors and signed by the Chairman of the Manufacturers Committee, relating to this subject, was turned over to him. During the luncheon hour, he hurriedly digested the contents of this letter and summarized points he believed to be of

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It's Better To Know Than To Guess

Moral: Don't guess about your resistance welding equipment

The most comprehensive book ever published on resistance welding. Complete with charts, diagrams and photographs. Free to those using resistance welding, when requested on company letterhead.

A LITTLE KNOWLEDGE may be a dangerous thing—especially when it comes to resistance welding equipment—in operating it correctly and keeping it in order. That's where Mallory experience is ready to help you—you don't have to guess, you can *know!*

What's the best kind of resistance welding for your job? What kind of welding electrodes should you use? When and how should you dress them? Questions like these, if properly answered, can save production time, conserve materials, result in better welds—*and Mallory engineers are ready to answer them!* Get acquainted with us by writing for a free copy of the Mallory Resistance Data Book. Meanwhile, observe these do's and don'ts:

DO'S

1. Use proper capacity welding machine for the job.
2. Design welding fixtures and clamps with non-magnetic materials whenever possible.
3. Provide suitable fixtures for holding the work in position prior to applying electrodes.

DON'TS

1. Avoid using a low capacity welder for heavy welding jobs.
2. Avoid placing or fastening steel parts or fixtures in the throat area on the welding machine.
3. Don't use welding tips, wheels or dies to form or shape parts in the welder.

In the United Kingdom, made and sold by MALLORY METALLURGICAL PRODUCTS LTD. (An Associate Company of Johnson, Matthey & Co. Limited) Hatton Garden, London, E. C. 1

P. R. MALLORY & CO. Inc.

MALLORY STANDARD RESISTANCE WELDING ELECTRODES

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

particular importance. The reading of his summary provoked considerable discussion.

Reduced to a minimum, the complaints against present arrangement for participation in the National Metal Exposition are —the show is too large; welding identity is lost; large show can be held only in a limited number of industrial centers; exposition and hotels are overcrowded; large number of sessions scheduled at one time makes impossible attendance at all sessions of interest to members. Arguments in favor of present arrangements are—metal exposition affords excellent opportunity for showing wares to new customers; equitable attendance at technical sessions. Separate show would mean duplication of shows; quantity of space required in separate show sufficient only for Hotel Show; operating exhibits prohibited in Hotel Show. If separate show, or not show, is held in connection with Annual Meeting, attendance will be greatly reduced. Cost of setting up an independent organization to conduct separate show is high and must be borne jointly by the SOCIETY and the manufacturers, or by either, independently. There is certain liability connected with employment of new management as compared with management, highly experienced in handling exposition and hotel arrangements. There is the possibility of manufacturers and the SOCIETY forfeiting prior rights in further participation in National Metal Expositions, if present arrangement is discontinued now.

It was agreed that inasmuch as the welding manufacturers are mostly concerned with any change in present exposition arrangement, their interest ought to be properly guarded, and in that direction, suggestion was made that the Chairmen of the Manufacturers, Convention and Program Committees, Mr. Tinnon acting as Chairman, consider the advisability of acquainting Mr. Eisenman with problems confronting A.W.S. and the welding manufacturers in respect to participation in the National Metal Exposition and Congress, seek his counsel in remedying these difficulties.

After discussion, it was voted to request the Chairmen of the Manufacturers, Convention and Program Committees to consider this matter and report back to the Directors.

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LINCOLN APPOINTS CONSULTING ENGINEER

The Lincoln Electric Co. of Cleveland, Ohio, announces the appointment of R. H. Davies as consulting engineer in charge of the educational work of the Company.

Mr. Davies has had wide experience in the industrial engineering field. For the past 2½ years he has been the Lincoln representative in Washington, D. C., where he did consulting engineering work with the Army, Navy and other government agencies. In this capacity he was consulted on many welding problems which were vital to the war effort.

R. H. Davies

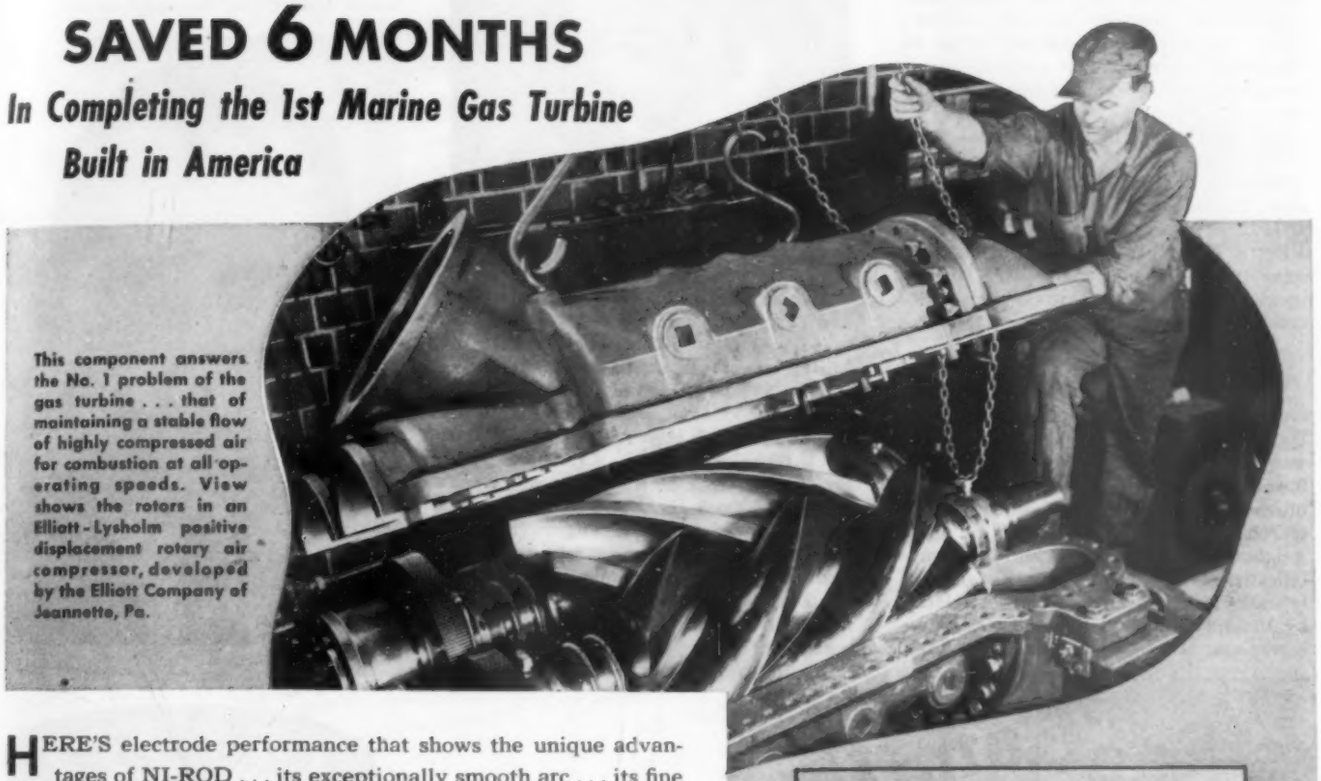
He received his education at the University of Minnesota after which he was employed by the Lockheed Aircraft Corp. where he did Production engineering work on the Hudson bomber and the P-38 Lightning.

He later became connected with Northrop Aircraft, Inc., starting at their new plant at Hawthorne, Calif., where he did considerable development work on the Northrop patrol bomber and "Flying Wing." He was given the assignment of developing all production and tooling methods for experimental and prototype

How

SAVED 6 MONTHS

In Completing the 1st Marine Gas Turbine Built in America



This component answers the No. 1 problem of the gas turbine . . . that of maintaining a stable flow of highly compressed air for combustion at all operating speeds. View shows the rotors in an Elliott-Lysholm positive displacement rotary air compressor, developed by the Elliott Company of Jeannette, Pa.

HERE'S electrode performance that shows the unique advantages of NI-ROD . . . its exceptionally smooth arc . . . its fine wash . . . and the ease with which it allows the welder to lay a smooth bead, non-porous and crack-free, on any part of a casting.

In this, as in other cases, experience shows that NI-ROD is as easy to handle as the best of mild steel electrodes and that it provides strong, sound, machinable welds . . . generally without the need of pre-heating.

35¢ WORTH OF NI-ROD SAVED BUILDING NEW ROTOR

Without preheat...The Elliott Company of Jeannette, Pa., repaired a "V" shaped groove, about ⅛" deep, ⅜" wide and 12" long, made when a tool slipped during a finishing cut in the female rotor of an air compressor like that shown above.

Only 4 (four) ⅛" diam. electrodes were used...two passes were required to fill the groove. After welding, the rotor was finished by turning and profiling to a tolerance of ±.001".

Savings on the rotor amounted to $2,000...with a cost of only about 35¢ for the NI-ROD used. But, more important ...this NI-ROD repair job saved the 6 months that would have been needed to build and install a new rotor.

Use NI-ROD for on-the-job repairing of broken or worn castings . . . and for all work on cast iron where strong, sound, machinable welds are essential. Write for booklet describing the properties, applications and handling of NI-ROD.

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Order a 5-lb. package of NI-ROD and test it for yourself. Your nearest INCO distributor has it on his shelves.

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aeroplanes and took an active part in the building of several confidential aircraft components of magnesium. Here he collaborated with W. H. Pavlecka in the development of the Heliarc welding process for magnesium.

Mr. Davies next became associated with Henry J. Kaiser where he was first plant engineer in the building of Kaiser's large magnesium plant, the alloy plant, the ferrosilicon plant and the magnesium sand-casting foundry at Permanente, Calif. After the construction period he was made superintendent and was also in charge of production and plant development.

Mr. Davies will make his headquarters at Cleveland where he will act as consultant on the use and design of welded steel in machinery manufacturing, and structural construction. The Lincoln Electric Co. expects to make his services available to industry generally. He is a member of the AMERICAN WELDING SOCIETY.

PRIEST PROMOTED

Appointment of H. Malcolm Priest as manager of the railroad research bureau, United States Steel Corp. subsidiaries, was announced recently by presidents of four subsidiary companies serviced by the bureau. Mr. Priest will supervise research and design in the field of lightweight railroad equipment and other mobile structures, through the application of low-alloy, high-strength steels produced by the corporation. The subsidiaries he serves are: Carnegie-Illinois Steel Corp.,

Columbia Steel Co., National Tube Co. and Tennessee Coal, Iron and Railroad Co.

He is a civil engineering graduate of Massachusetts Institute of Technology. His previous industrial experience includes association with the American Bridge Co. and later with the Chicago Rock Island and Pacific Railroad. During World War I he was a research engineer at McCook Field and then assistant professor of structural engineering at Purdue University. In 1923 he returned to his association with United States Steel Corp. subsidiaries and ten years later joined the U. S. Steel railway research bureau.

McCLUNG JOINS LUKENWELD

E. R. McClung, Jr., has joined the staff of Lukenweld, Inc., division of Lukens Steel Co., as Welding Engineer, it was announced recently by W. S. Wilbraham, production manager for Lukenweld.

Born in Brooklyn, N. Y., McClung attended Augusta Military Academy in Virginia, and the Severn School in Maryland. He was graduated from the U. S. Naval Academy at Annapolis in 1934 with

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Use National Carbide in the Red Drum

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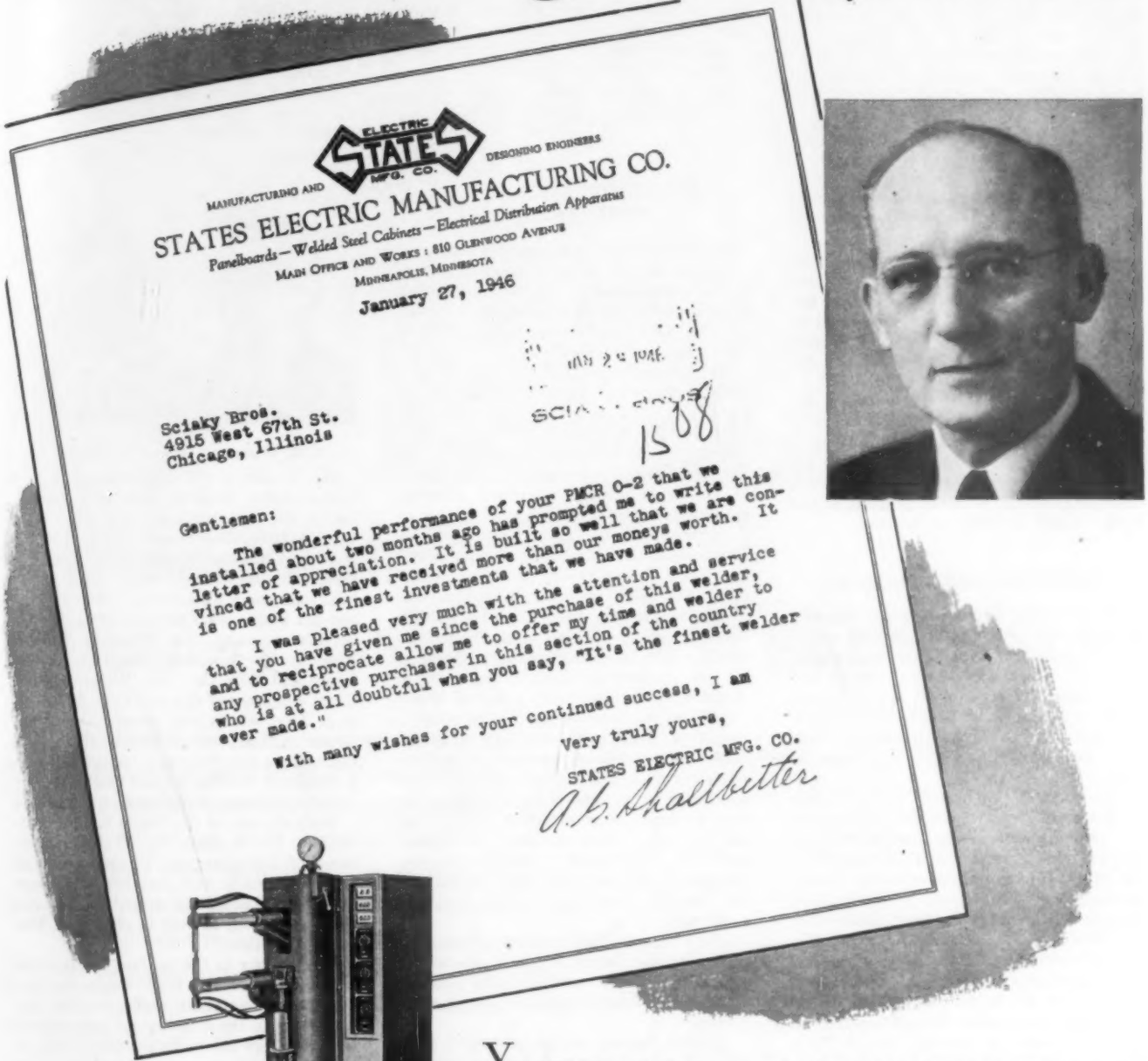
Them's Strong Words, Mr. S.!



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January 27, 1946

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1508

Sciaky Bros.
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Gentlemen:

The wonderful performance of your PMCR O-2 that we installed about two months ago has prompted me to write this letter of appreciation. It is built so well that we are convinced that we have received more than our moneys worth. It is one of the finest investments that we have made.

I was pleased very much with the attention and service that you have given me since the purchase of this welder, and to reciprocate allow me to offer my time and welder to any prospective purchaser in this section of the country who is at all doubtful when you say, "It's the finest welder ever made."

With many wishes for your continued success, I am

Very truly yours,

STATES ELECTRIC MFG. CO.

A. B. Shallbetter

SERIES PMCR-O

The machine praised by Mr. Shallbetter is one of a Series of small completely automatic welders. Several features make it unique for a machine of its size. Heavy duty roller bearings at the fulcrum point of the rocker arm assure long life. Retraction stroke is provided. Machine is a complete self-contained unit with electronic controls mounted in hinged cabinet convenient to operator. Standard frame and control unit may be furnished with any of 5 transformer sizes: 20, 30, 40, 50 and 75 KVA. Throat depth can be varied by a choice of 5 arm lengths: 12", 18", 24", 30" and 36". Thus, machine can be chosen to cover a range of capacities from 28—22 up to 28—11 gauge clean mild steel.

Write for descriptive bulletin No. 112-D

YES SIR! When the busy owner of a plant making electrical distribution equipment takes time out to sit down and write the above letter, he must have something to shout about.

It's the result of a long-standing conviction on the part of Sciaky Bros. that resistance welding is strictly a *production process*. Machines must therefore be designed to both, (1) produce sound welds and (2) stand up under continuous production conditions. To this end, Sciaky welders are engineered for *long life* and to be as *maintenance-free* as possible.

Furthermore, when you have trouble (and who doesn't, now and then), our service engineers are always on call to help out. We'd like to have the opportunity of proving "It's the Finest Welder ever Made" to you, too.

SCIAKY BROS.

4925 W. 67th St. CHICAGO 38, ILL.

the Bachelor of Science Degree, and is a member of the AMERICAN WELDING SOCIETY.

In his present position with Lukenweld, Mr. McClung will be responsible for procedures, techniques, training and new developments in welding. For the past seven years he has been with the New York Shipbuilding Corp., Camden, N. J., first as Assistant Welding Engineer and, later, as Welding Engineer.

SHAPES OF THINGS TO COME

A unique booklet has just been published by Hobart Brothers Co. entitled "Shapes of Things to Come."

This booklet was written some time ago by Robert Kinkead, a welding consultant, and the designs shown in the book are figments of his imagination developed to show the possibility of welding design without tramping on the toes of any designer.

These were designed quite some time ago but were not put into print because of their rather unusual character, but after the publicity which the atomic age received, Hobart Brothers, Troy, Ohio, decided to go ahead with the printing of the book. Copy available on request.

STEAM DETERGENT CLEANING

Of increasing interest to plant superintendents and others responsible for maintenance cleaning of machinery and equipment are the savings in time, money and effort being effected by steam detergent cleaning methods. A booklet on this subject has been published by Oakite Products, Inc., and is available free upon request.

Described in this booklet are many applications of steam detergent cleaning for (1) cleaning machinery equipment and parts for subsequent repair and overhaul, (2) preparing equipment surfaces for repainting or refinishing, (3) cleaning equipment too large for tank immersion, or where suitable tanks are not available, (4) paint stripping. Emphasis is placed on steam detergent cleaning as a simple, fast method for safely removing grease, oil, dirt, sand and other deposits from all types of equipment through the combination of mechanical force, controlled heat and effective detergent action of recommended materials. Savings of nearly 50% of former costs and over 75% of time and effort are reported on some cleaning operations using this modern method.

Write to Oakite Products, Inc., 18E Thames St., New York 6, N. Y., for a free copy of their booklet on "Steam Detergent Cleaning."

BRAZING NEWS

"Low Temperature Brazing News" No. 33, is an interesting pamphlet issued by Handy & Harman, 82 Fulton St., New York 7, N. Y., tracing the expansion in the use of Sil-Fos and Easy-Flo brazing alloys in war and civilian production, which we believe will be of great interest to many of our readers.

Copies will be mailed upon request addressed to the manufacture.

INFORMATIVE BOOKLET ON POWER BRUSHES

A 24-page booklet designed to serve as a virtual encyclopedia of power brush usage in manufacturing operations has just been issued by the Technical Department of The Osborn Manufacturing Co. of Cleveland.

The contents of this $8\frac{1}{2}$- x 11-in. generously illustrated publication includes a full-page treatise on factors that enter into the selection of brushes, taking into consideration methods that should be employed to gain the greatest use from each of the wide variety of power brushes manufactured by the company.

Fifteen separate tables give detailed information on a variety of factors entering into efficient power brushing operation. One table, for example, lists six elements which can be varied to modify brushing characteristics and shows the average effect of independently increasing or decreasing these listed factors. Another table deals with a list of brush types and information needed to make a tentative selection of a brush for an initial trial. Other tables go into such subjects as adjustments which can be made in brush specifications or operating conditions to achieve different or modified results, one on removing burrs, another on surface finishing, finishing to improve wearing qualities, and numerous others which discuss equally important power brushing problems.

More than 30 illustrations graphically depict actual power brushing operations and some of the achievements possible with proper brushes and suggested techniques.

Another feature of the booklet is a series of tables which group various types of Osborn brushes and wheels, showing the brush trim length, and application notes referring to the use of individual models and sizes. There are eleven of these separate tables.

The booklet is available without charge. Inquiries should be addressed to: The Osborn Manufacturing Co., 5401 Hamilton Ave., Cleveland 14, Ohio.

WEIGER AND WEED FORM NEW COMPANY

Joseph A. Weiger, Vice-President of P. R. Mallory & Co., Inc., and Henry D. Weed, Jr., Manager of the Resistance Welding Alloy Division of the company, have resigned to form a new manufacturing firm, the Weiger Weed & Co., to specialize in resistance welding electrodes, electrical contacts and special metallurgical products. Headquarters of the new company will be in Detroit at 11644 Cloverdale Ave. where office and production facilities have been established.

J. A. Weiger Henry D. Weed, Jr.

Mr. Weiger, a well-known figure in nonferrous alloy research and development, joined the Independent Lamp and Wire Co., in 1916 after receiving his B.S. degree in Chemical Engineering from the University of Pennsylvania. During the next four years, he developed the electrical contact and special metallurgical division of this company. In 1920, the General Electric Co. acquired the Independent Lamp and Wire Co. Mr. Weiger became Chief Engineer of the new G.E. Metallurgical Div. which was named the Elkon Works. Here, he pioneered the use of Elkonite, a new tungsten copper alloy, as a resistance welding die and electrode material for the mass production of motor cars.

With the sale of the Elkon Works to the Mallory Co. in 1925, Mr. Weiger became head of Metallurgical Engineering, and later was made vice-president and manager of metallurgical activities. During the war period, he was in charge of Mallory production.

Mr. Weiger is the author of numerous technical articles in trade magazines and hand books and has made notable contributions to the commercial development of hard high-conductivity alloys for resistance welding, and to improvements in tungsten, molybdenum, silver alloys and precious metals for electrical make-and-break contacts.

Mr. Weed was well known in Detroit welding circles before joining the Mallory Co. He was graduated from Phillips Exeter Academy in 1924 and the University of Virginia in 1928 with a B.S. degrees After ten years' experience in securitie

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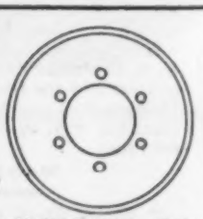
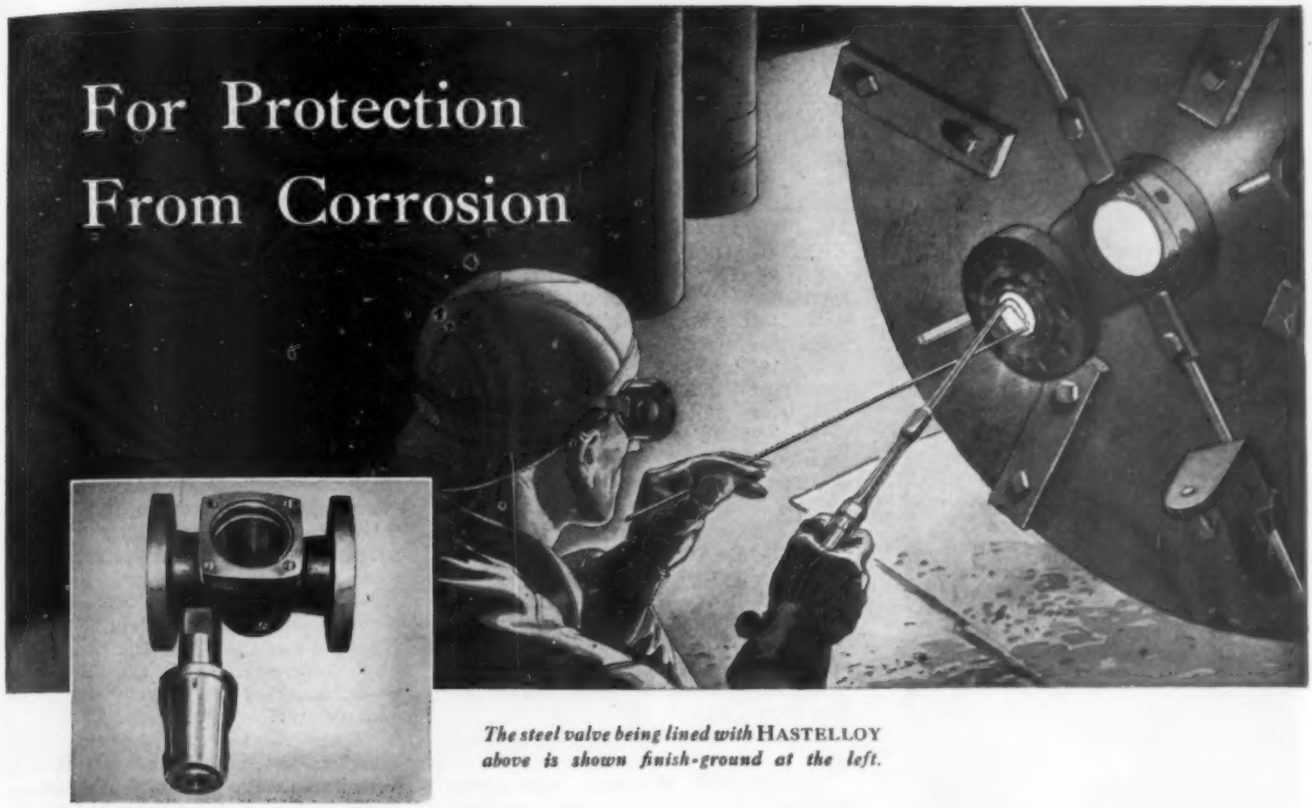


THE ELECTROLOY CO. INC. 1600 SEAVIEW AVE. BRIDGEPORT, CONN.



The steel valve being lined with HASTELLOY *above is shown finish-ground at the left.*

Refinery Valves are HASTELLOY Faced

Steel valves last only a few days in aviation gasoline isomerization units because of the extremely corrosive materials used in processing the gasoline. When steel valves are lined with HASTELLOY, however, they give many months of uninterrupted service.

Facing with HASTELLOY nickel-base alloys is a very useful procedure for maintenance men and engineers on processes where corrosion is a problem. With HASTELLOY rod, points of corrosion can be easily covered to give them long life.

The HAYNES line includes a wide range of corrosion- and wear-resistant alloys, which make it possible to increase many times the useful life of parts subjected to corrosion or wear. Our engineers will be glad to help you develop hard-facing procedures for your product. Write for further information.

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HAYNES TRADE-MARK *alloys*

and finance, he became interested in welding and represented the Page Steel & Wire Co. in the Detroit area. In 1940, he became associated with the Detroit office of the Mallory Co. In 1942, he went to the plant in Indianapolis as sales head of the Resistance Welding Division. More recently, he was made manager of all activities of this division.

OBITUARY
William D. Flannery

William D. Flannery, who was born August 19, 1889, died February 13, 1946. Mr. Flannery received his early education in the Elizabeth, N. J., schools. He served his apprenticeship as machinist with the S. L. Moore Co., Elizabeth, and was employed by Mr. C. Bournonville who invented the first acetylene torch brought to this country from France. Mr. Flannery was Vice-President of the K-G Welding & Cutting Co. for about fifteen years. For the past fifteen years he was owner-manager of the Harris Calorific Sales Company of New York. He was President of the International Acetylene Association 1930–31. He is survived by his wife, Mary Beirne Flannery; three sons, William R., John J. and James Peter; and one daughter, Margaret Anne Flannery. Mr. Flannery resided at 969 Coolidge Road, Elizabeth, N. J.

AMERICAN BUREAU OF SHIPPING ANNUAL MEETING

The 84th Annual Meetings of the Board of Managers and Members of the American Bureau of Shipping were held recently in the Bureau's boardroom, 47 Beaver St., New York City.

In his remarks, President Luckenbach said:

"Construction of large, ocean-going merchant types of steel vessels over 2000 gross tons in 1945 for the Maritime Commission and private interests again reached war production figures, aggregating 1041 units of 7,614,898 gross tons and 10,304,644 deadweight tons, in which was incorporated 5,964,380 hp. of propelling machinery. This added to the total completed in the war years 1939 through 1944 makes a grand total of 5076 vessels of 38,433,192 gross tons, 54,395,755 deadweight tons, with 22,950,058 hp. of propulsion machinery.

"Of the total of 1041 large merchant vessels constructed in 1945, 853 were of the cargo or combination transport and cargo types, representing 5,845,315 gross tons and 7,517,247 dead weight tons with 4,713,500 hp. of propulsion machinery. Large deadweight tonnage vessels of the mass production duplicate types such as the Liberty and Victory ships constituted the greater proportion of the vessels in this category completed during the year. Victory ships accounted for almost one half the deadweight tonnage of the dry cargo vessels completed, totaling 322 units of 2,449,568 gross tons and 3,378,043 deadweight tons. Liberty ships completed totaled 144 of 1,022,748 gross tons and 1,503,044 deadweight tons. The remaining vessels completed included standard types such as the C1-M Diesel propelled cargo ships, the C1, C2, C3, C4 and P2 types, many of which were altered for military service.

"A new and important addition to the American merchant marine was 11 fully refrigerated cargo vessels, 6 of which are of the C_2 type and 5 constructed for the United Fruit Co. The first specially designed lumber cargo carrier to be built in the United States in many years was completed in 1945. Three sister ships are now

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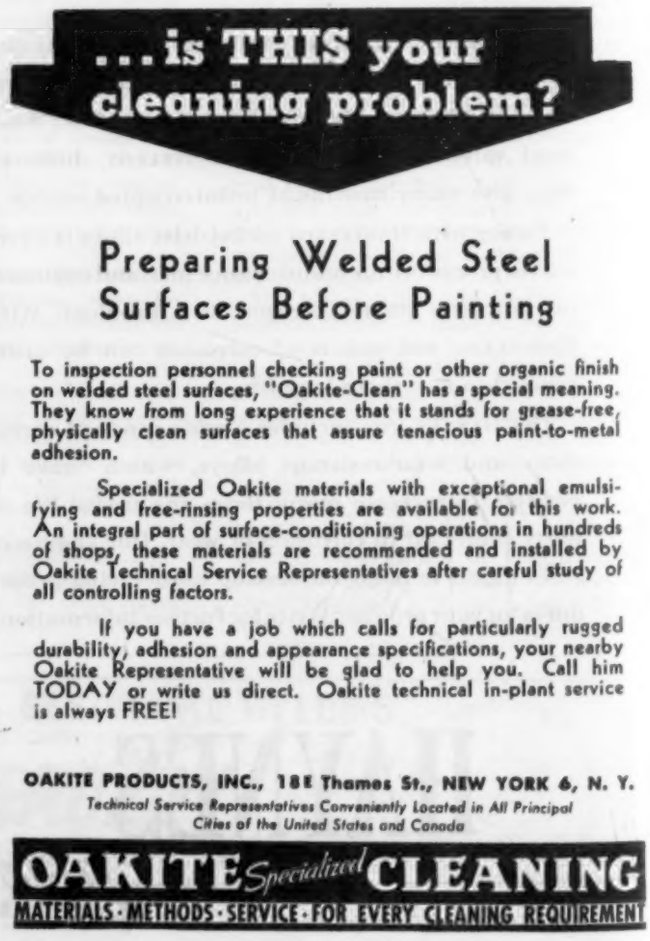
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To inspection personnel checking paint or other organic finish on welded steel surfaces, "Oakite-Clean" has a special meaning. They know from long experience that it stands for grease-free, physically clean surfaces that assure tenacious paint-to-metal adhesion.
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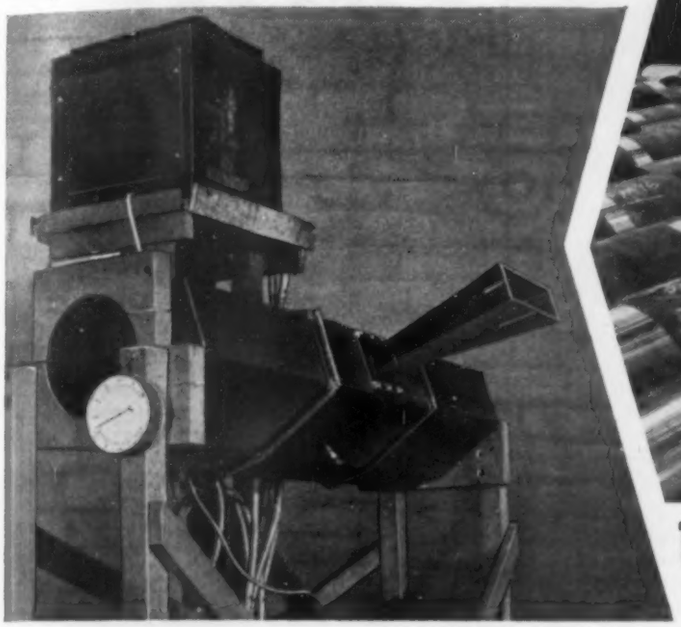
1928 When it became necessary to produce welds to meet early X-ray inspection, A. O. Smith developed a mineral-coated electrode which virtually eliminated porosity and at the same time materially increased the rate of deposition.



1946 The development of X-ray inspection, further SMITHway developments in mineral coatings for electrodes, and the SMITHway mastery of welding preparation and techniques, have made possible more than *one mile a day* of X-ray quality welding on torpedo airflasks in A. O. Smith plants.

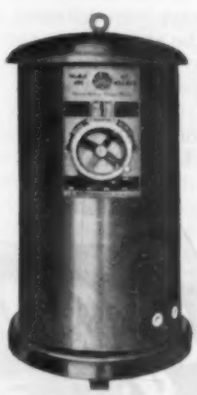
More Than 1 Mile a Day of X-Ray Welding

THE PROOF IS IN PRODUCTION

Constantly leading the way in advance of production requirements, SMITHway welding developments are backed by a program of continuous welding research. For 29 years—in laboratories and in actual plant production—it has been a search for improvement that never ends.

As many as 320,000 SMITHway Electrodes are used daily in A. O. Smith plants. Millions more are used by other manufacturers. Here's proof-in-production of the quality and uniformity of the electrodes made *by* welders *for* welders.

For detailed specifications of SMITHway Certified Electrodes and their application to specific welding jobs, send for the SMITHway Welding Catalog.



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WELDING ELECTRODES
made by welders . . . for welders

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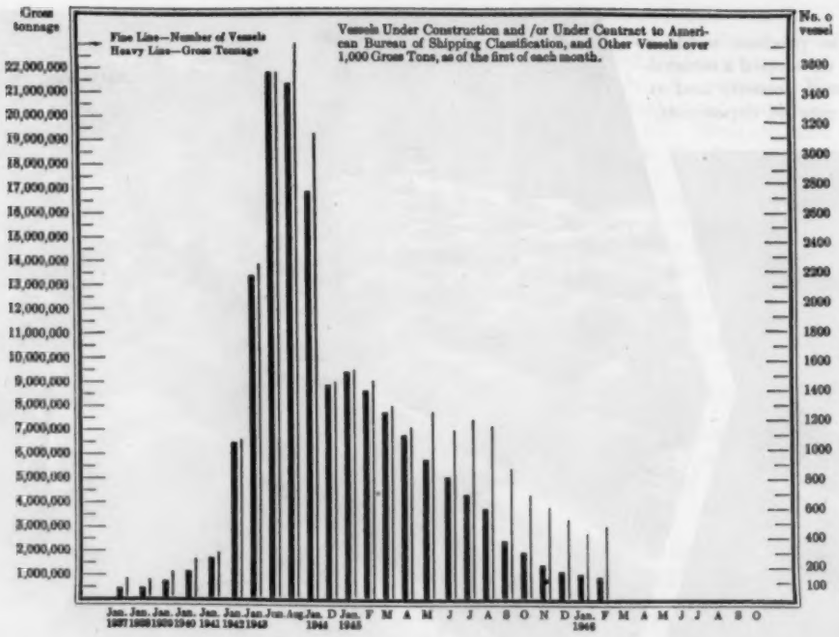

under construction. An outstanding completion during the year was the bulk ore carrier *Venore*, of 24,251 deadweight tons, equipped with high-pressure, high-temperature geared turbine propelling machinery of 13,000 shaft horsepower. Three addditional vessels of this type are being built and four more are contemplated.

"Tankers constituted almost one third of the deadweight tonnage of merchant vessels completed in 1945. A total of 188 tank ships of 1,769,583 gross tons and 2,787,397 deadweight tons, with 1,284,680 horsepower of propulsion machinery, were produced. This brings the total production of tankers during the war years 1939 through 1945 up to 775 of 7,566,642 gross tons and 12,010,643 deadweight tons. This fleet of new tankers is twice as large in number and about three times greater in gross and deadweight tonnage than the tanker fleet flying the American flag in 1939, which total 366 vessels of 2,672,716 gross tons and 4,282,100 deadweight tons. In carrying capacity it represents approximately three fourths the total tanker fleet existing throughout the world in 1939, when there were 1507 tankers of 16,008,-300 deadweight tons. There exists under American ownership 987 tank ships of about 14,300,000 deadweight tons, with an average age of about 2½ years, or approximately one-half the number and deadweight tonnage of the tankers in existence throughout the world today. With the increased speed available in the new tankers, making for quicker turnaround, and the larger average deadweight capacity, the United States flag tanker fleet is now the most efficient and capable in the world.

"Completed during 1945 were three of the largest tankers in the world, each of about 23,400 deadweight tons. Also completed in 1945 was the last of the standard turbo-electric drive tankers. The building program for this type of vessel represents the greatest mass production of duplicate tankers ever embarked upon, encompassing a total of 525 vessels of 8,672,028 deadweight tons.

"As in each of the recent war years, Pacific Coast shipyards completed in 1945 the largest percentage of the total number and tonnage of merchant vessels built by all yards throughout the country, finishing 454 vessels of 3,485,581 gross tons. Atlantic Coast yards delivered 324 vessels of 2,533,456 gross tons, while on the Gulf 235 vessels of 1,438,855 gross tons were turned out. Great Lakes yards produced 54 merchant vessels of 205,470 gross tons, all of which were of the C1-M Diesel propelled type of cargo vessels. For the fourth successive year the State of California led the country in producing merchant vessels, turning out 330, or almost one third the total completed in the United States. The State of Oregon was second with 111 vessels. The large merchant ships completed in 1945 were produced by 39 shipyards.

"A number of projects contemplating the construction of specialized types of vessels for specific trade routes are now in the designing stage. Included are a number of large high-speed combination passenger and cargo-carrying vessels for transoceanic traffic and vessels for the shorter hauls. American flag shipping companies have been during the past year, and are at present, active in assembling their postwar trade fleets. A large expenditure of capital is involved in acquiring new fleets to replace tonnage lost during the war or now obsolete. In addition, there are many projects for small vessels for special service, including car ferries and car floats, ferry boats, coastal cargo vessels and tankers, fishing vessels, towboats, tugs and oil and cargo barges. Vessels under construction or under contract to be built to American Bureau of Shipping class at present total 501 vessels of 1,021,894 gross tons. Practically all of these vessels will be completed during 1946.

"The Liberty shipbuilding program was completed during the year and a number of these vessels have already been withdrawn from service; in all 2710 of these vessels were built. The structural alterations found desirable as a result of failures in the earlier ships of this type have been put into effect in the great majority of the vessels and the continuous decrease in the frequency of major failures being experienced in service would go to show that these remedial measures have been quite effective. In the light of the earlier failures on the Liberty ships special consideration was given to design details and later designs such as the Victory ships, of which about 531 have been delivered, and it is gratifying to be able to state that no serious failures have so far been reported on vessels of this particular type.

"It is now clearly recognized that the structural design of a welded ship constitutes a special problem distinct from that of its riveted counterpart which can only

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The same small-sized housing is retained, rotatable through 360°. Strength has been increased at vital points. The new features increase the ruggedness and improve the function of the mechanical and electric internal structures.

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SHIELD: Ray-proofing by a heavy copper hood. A lead-loaded bakelite shield insures greater electrical stability and inhibits internal scattering.

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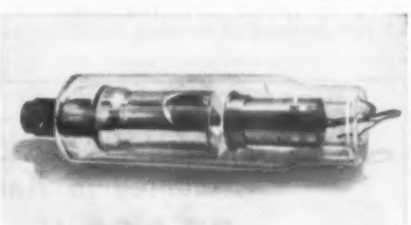
20° target angle, available with single focus B spot, either water-cooled or forced-air-cooled.



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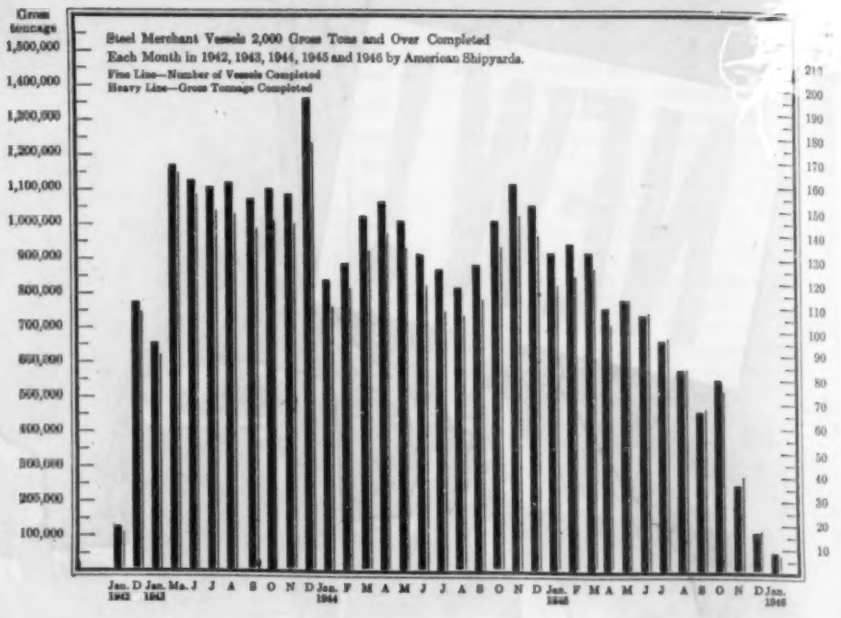
be solved by analysis of service failures combined with fundamental research into all the phases of the problem including the quality of the steel entering into the construction. The analysis of Surveyors' reports of damage surveys with the object in view of determining the causes of service troubles which will point the way to their prevention in future is an important part of the everyday work of the Technical Staff.

"One useful result of the structural troubles experienced in our larger welded ships was the appointment by the Secretary of the Navy of a Board to Investigate the Design and Methods of Construction of Welded Steel Vessels on which the Bureau is represented by the Chief Surveyor. No fewer than 35 major research projects, mostly financed by the Government, were set up in leading universities, the Bureau of Standards, and many other laboratories throughout the country to investigate the various phases of the problem. This Board has issued two Interim Reports which have been published. Some 20 of these projects have been completed and the remainder are expected to be finished within the next few months. Through a mutual arrangement made for exchange of data, full information with regard to the research work being carried out by a corresponding investigating committee in Great Britain, i.e., the Admiralty Ship Welding Committee, has been made available to the Board. Considerable research is being carried out by the Welding Research Council to which the Bureau contributes and important experimental work on welded problems is being carried out by some of our shipbuilding companies. The volume of this important research work is unprecedented and when the results are properly correlated will undoubtedly have a beneficial effect on future welded ship construction.

"I would like to call your attention to the case of a Liberty type vessel *James Otis* built February 1942 at Richmond, Calif. On November 17, 1942, this vessel stranded on Wessels Reef, Alaska, depth of water over reef reported about 2 ft. less than vessel's drafts at time of standing. Vessel was taken to Portland, Ore., for survey of bottom which showed a total of 113 bottom shell plates severely indented, of which 22 were found fractured, the damage extending from frame 11 just forward of forepeak bulkhead to frame 166, the forward end of stern frame. Intercoastal longitudinal girders in double bottom tanks in 258 frame spaces between floors were so badly damaged partial renewals were required. One hundred eighty-seven solid floors and 58 skeleton floors similarly required partial renewals. The innerbottom tank top plating of No. 2 hold was buckled over an area of approximately 200 sq. ft. The vessel was later taken from Portland to Vancouver, B. C., where repairs were carried out between January 16, 1943, and March 12, 1943, at an approximate cost of $265,000. I understand that this vessel did not leak a drop. This is a specific case of how well welding can take it.



"I reported to the Board of Managers at the Semi-Annual Meeting that two outstanding types of vessels were put into service during the year. They are the new tanker SS *Phoenix* and the new ore carrier SS *Venore*, both most noteworthy vessels, each excelling but in different factors. The *Phoenix* is the largest all-welded vessel in the world and the *Venore*, while welded to a large degree, is not completely welded and has the most modern machinery installation with pressures hitherto untried on shipboard.

"As I said previously, we are emerging from the largest shipbuilding program ever projected in history. At its conclusion over 38 million tons of new merchant vessels of varying types will have been constructed in the United States. The total of merchant vessels in operation by all nations of the world on Sept. 1, 1939, was reported to have been about 52 million gross tons, so in other words in the few war years under the impetus applied, the United States constructed about 75% as much gross tonnage as there existed in the world just prior to World War II. It might be of interest to note that about 20% of the new tonnage constructed was tankers.

"It is to be hoped that the Government will find means and open ways so that the fine merchant marine which has been built at the expense of the people of the United States for the purpose of winning the war can now be used in establishing a permanent peace by delivering the products of the American exporter to foreign lands, where they are much needed, and bringing back such imports as we can use. The American Flag will then be seen throughout the ports of the nations of the world, which should reflect our national prestige to those of other lands."

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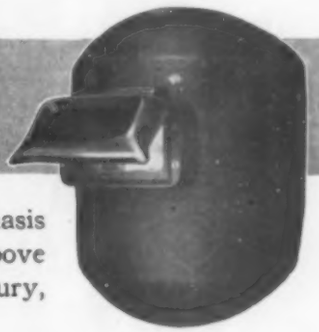

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EMERGENCY PACK TYPE CUTTING OUTFIT

A preliminary Bulletin has been issued on the Victor Pack Type Emergency Flame Cutting Outfit originally designed and produced for the Navy—and now to be offered to Fire Departments, Rescue Squads, State Highway Police and industry.

Tee Hand Cutting Torch Is so Supported in the Harness That it Can Be Instantly Removed for Cutting Operation.

The compactness and portability of this particular outfit is particularly appealing.

Copy may be obtained from the Victor Equipment Co., 844–54 Folsom St., San Francisco.

STAINLESS STEEL ELECTRODES

The Lincoln Electric Co., Cleveland, Ohio, announces two improved electrodes for shielded arc welding of stainless steels. Known as "Stainweld A 7" and "Stainweld A 7-Cb," they are made for welding steels of the 18% chromium and 8% nickel type in all positions.

"Stainweld A 7," which was discontinued during the war, has been improved and is now being manufactured. It is recommended for use with stainless steels designated by American Iron and Steel Institute as Nos. 304 and 308. It produces an extremely smooth and steady arc with easy slag removal and is suited for operation on direct current or the higher voltage type alternating current welding units.

This new electrode is available in $^{1}/_{16}$-, $^{5}/_{64}$- and $^{3}/_{32}$-in. sizes; 18-in. lengths, center grip and $^{1}/_{8}$-, $^{5}/_{32}$- and $^{3}/_{16}$-in. sizes; 14-in. lengths, end grip.

"Stainweld A 7-Cb" is columbium stabilized and has operating characteristics similar to "Stainweld A 7." This electrode is recommended for use with stabilized 18–8 stainless steels designated by American Iron and Steel Institute Nos. 321 and 347.

This new electrode is furnished in $^{3}/_{32}$-in. size; 18-in. length, center grip and $^{1}/_{8}$-, $^{5}/_{32}$- and $^{3}/_{16}$-in. sizes; 14-in. lengths, end grip.

Both "Stainweld A 7" and "Stainweld A 7-Cb" shielded arc electrodes are also recommended for weld surfacing where an austenitic (work-hardening) surface of medium hardness and good corrosion resistance is required. It provides excellent resistance to impact and abrasion. Hardness of single layer, as deposited on mild steel, 35 Rockwell C; work hardened, 48 Rockwell C; of multiple layer, as deposited, 85 Rockwell B; work hardened, 42 Rockwell C.

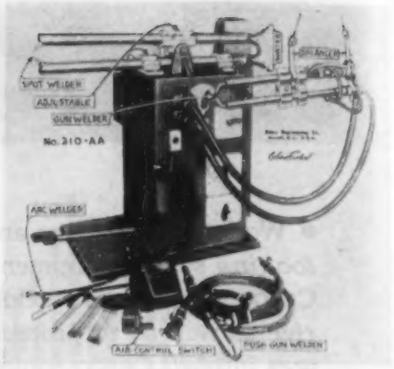
Shape of weld bead with either electrode generally is convex.

Properties of all-weld metal specimen (average for various sizes of electrodes): tensile strength, 85,000 to 95,000 psi. Elongation is 2 in., 35 to 50%.

SPOT WELDER

The No. 310-AA Universal Spot Welder offered by the Eisler Engineering Co., 750 S. 13th St., Newark 3, N. J., is especially suited for spot welding all types of sheet metal work. In addition, the unit can be used with a hand-operated push type and tong type gun welder, and the a.-c. arc welding (100–400 amp.). The gun welder can also be supplied with air operation.

The novel feature of this machine is the unusually deep throat provided by both horns which can be lengthened or shortened by sliding them in the bearings to fit the size and type of sheet metal work to be welded. Another great advantage is that the horns are mounted on the top of the fabricated case and thus the machine is suitable for spot welding large sheet metal parts.



The machine is intended for deep sheet metal work of light gage, but will also weld heavier work in the short throat position. The kilovolt-ampere rating of the welders can be from 20 to 50 kva. at the shortest throat depth. The horns as well as the tip holder and tips are water cooled. The machine is available for air as well as foot operation. Wiring permits independent operation of spot welding and arc welding.

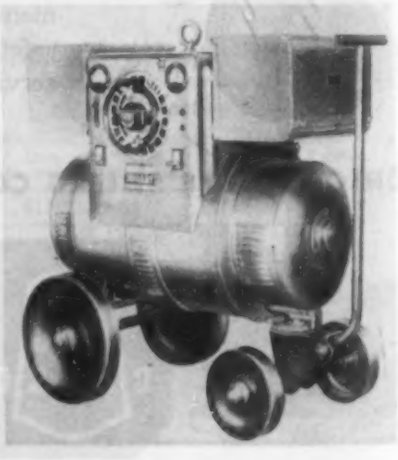
BATTERY CHARGER–WELDER COMBINATION

A battery charger–arc welder combination for charging railway coach batteries and electric arc welding has been developed by The Hobart Brothers Co., Motor Generator Corp. Div., Troy, Ohio.

This dual purpose machine was designed especially for the railroads, but is adaptable to a wide variety of shops where batteries are charged and electric arc welding is done. It has complete, separate control panels with instruments—one for each battery circuit and one for the welding circuit. You can switch from charging to welding or from welding to charging as easily as you can operate a charger or welder separately.

The Model No. 496 is a Hobart 300-amp. electric motor-driven welder including MGC panel circuit for charging one railway coach battery at a maximum rate of 200 amp. at 50 v., d. c.

The Model No. 497 is Hobart 400-amp. electric motor-driven welder including MGC panel circuits for charging two railway coach batteries at one time and



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AO makes a complete line of welders' gloves and mittens —all designed to provide maximum protection with extraordinary comfort. To minimize the possibility of shriveling and shrinkage, only the highest grade of chrome tanned cowhide or horsehide is used. Durably constructed, they cost least in the long run.

AO also makes an excellent line of welders' clothing—coats, jackets, sleevelets, pants, leggings, spats, etc. Send for booklet giving complete details.

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AO 5x163 (above left)

Split horsehide—1-piece back and reinforcing leather strap around thumb crotch—seams welted at vulnerable spots. Has heavy liner on back of hand.

AO 5x143 (above center)

Split cowhide—1-piece back—Gunn cut—all vulnerable seams welted. Lined on back of hand.

AO TX100 (above right)

Split cowhide—Gunn cut—1-piece back. Double thickness of leather on first finger and thumb. Lined on back of hand from wrist to finger tips. Full gauntlet.

AO 6x141 Mitten (not illustrated)

Split cowhide 1-finger mitten. 1-piece back and palm. Crotch of thumb reinforced with wide leather strap. All vulnerable seams welted. Back of palm lined.

at a maximum rate per battery of 150 amp. at 50 v., d. c.

Each MGC charging circuit includes the following:

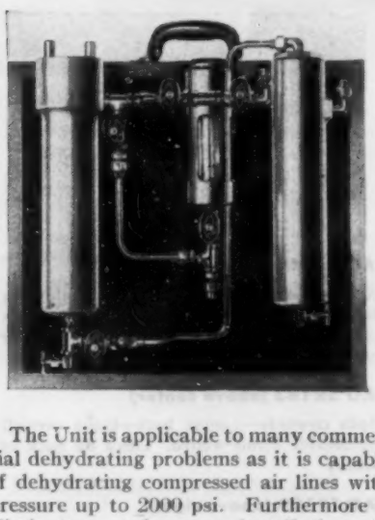
1—voltmeter for measuring voltage of generator and/or battery.
1—ammeter to indicate charging current.
1—200-amp. knife switch to open charging circuit.
1—175-amp. Fusetron in charging circuit.
1—automatic reverse current cutout (to prevent flow of current from battery to generator).

The welders are Hobart multi-range dual control electric drives with exclusive remote control and all the other improved welding features of the Hobart welding generators.

The Motor Generator Corp. Div. of The Hobart Brothers Co. will furnish complete details on request.

DEHYDRATOR UNIT

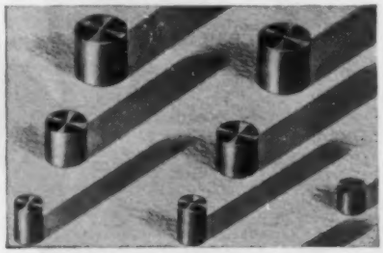
The accompanying photograph shows the D-10 Dehydrator Unit, manufactured by the Russell R. Gannon Co., Cincinnati, Ohio. This Unit was developed by The Gannon Co. for the armed forces during the war. Its function was to solve a difficult dehydration problem existing in the transmission lines of radar gear in the Army's huge B-29 bombers. This problem necessitated the control of moisture content, relative humidity and dew point of air and other gases. The installation of the D-10 Dehydrator Unit provided the solution. This Unit is portable and has a moisture pickup capacity of 50 gm. of water while maintaining a dew point of 90° F. below zero.



The Unit is applicable to many commercial dehydrating problems as it is capable of dehydrating compressed air lines with pressure up to 2000 psi. Furthermore it eliminates cumbersome installations in most instances and the dehydrating chemicals are so inexpensive to replace as to be expendable at a negligible cost. The Unit can be equipped with a precision-tested dew point color change indicator which insures accuracy of working conditions. For further information address The Russell R. Gannon Co., 704 Gwynne Bldg., Cincinnati 2, Ohio.

RESISTANCE WELDING TIPS

Long-time specialists in the production of molded composition metal, carbon and graphite products, Stackpole Carbon Co., St. Marys, Pa., has announced the addition of a unique line of resistance welding tips to its line. Two general grades known as Stackpole RW-1 and RW-2 are the direct result of specialized wartime research and are now being made available to industry in general. Characteristics include excellent heat and electrical conductivity. Use on extremely difficult spot-welding applications has proved the ability of these tips to retain their hardness under severe conditions.



Both materials can be supplied to practically any required shape or size and are furnished to the usual tolerance. In addition to the standard types RW-1 and RW-2, Stackpole specializes in the production of resistance welding tips for specific requirements. A copy of the Stackpole Welding and Brazing Products catalog 1B will be sent on request to the manufacturer.

"SIMPLIFIED" FARM WELDER

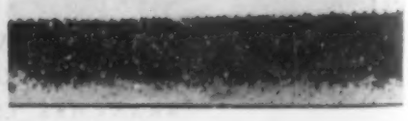
A new low-cost farm welder incorporating the popular Mutli-Range Dual Welding Control has been developed by The Hobart Brothers Co., Troy, Ohio, for operation on 230-v. single-phase rural power lines with a maximum input of 35 amp. to conform to rural electrification requirements for this type of welder. This special designed farm welder can be used with the standard 3-kva. transformer as provided by the power company and has a welding range of 20 to 180 amp. to produce sound welds with a minimum of skill using electrodes ranging from $^{1}/_{16}$ to $^{5}/_{32}$ in. diameter. Multi-Range Dual Control eliminates use of plugs and jacks and no live connections are exposed. Current adjustment is accomplished in 30 evenly spaced steps by the use of the large convenient hand wheel on front of the cabinet, and even smaller adjustments can be obtained with the switch in center of this hand wheel, which also functions to disconnect the welder from the power line.

Because of special, in-built construction, the striking voltage increases as welding current is reduced, making it very easy to start and maintain the arc under all conditions. This design also eliminates the use of complicated special devices such as relays and contactors that are intended to make arc striking easier, but are sources of maintenance trouble. A capacitor is included for power factor improvement.

Notable among other improved features of this "simplified" farm welder are the laminated transformer core of high-grade silicon transformer steel, highest quality of fireproof glass insulation throughout, cabinet of pressed steel arc welded into one piece for maximum rigidity and minimum vibration, approaching 86% efficiency at maximum load, large casters and light weight (224 lb.) which makes for easy portability.

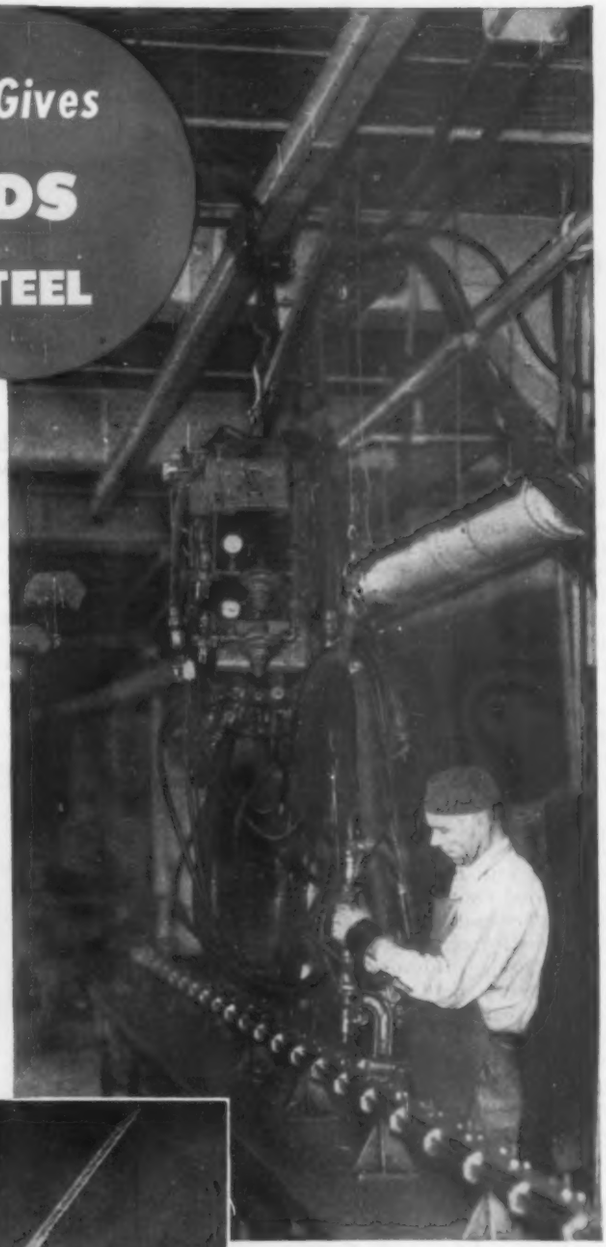
NON-PIT WELDING LENS

A new baked plastic lens coating from which smudge and smoke can be wiped with a damp cloth without affecting coating, and which is said to be considerably superior to previous types of coating for nonpit welding lenses, has been developed by Eastern Equipment Co., Inc., Willow Grove, Pa. Photo shows effects of weld spatter on lens which was partly coated by this new process. Accumulation of spatter on uncoated section would long since have made lens unusable, but coated section is hardly affected. New lens is available in plates for helmets and handshields and in 50-mm. size for goggles. A partly coated sample for your own test will be supplied free on request to Eastern Equipment Co., Inc., Willow Grove, Pa.



New Tempering Attachment Gives

STRONGER WELDS IN AIR-HARDENABLE STEEL



Ladder sections are welded on this specially designed welding machine, which is suspended from an overhead monorail and moves the length of the ladder side rail.

● Fire-fighting ladders of low-alloy steel are now being spot-welded by a new method at the American-La France-Foamite Corporation, Elmira, N. Y. The welding machines are equipped with G-E synchronous electronic control and a new G-E tempering attachment.

HEAT TREATING ELIMINATES BRITTLENESS

To meet exacting strength requirements, these lightweight ladders must have tough, ductile welds. Such welds cannot be made in air-hardenable steel by normal methods because chilling effects of the water-cooled electrodes would cause the weld nugget to be brittle. And the weld, as a result, would be weak.

Use of the tempering attachment, by which the work is heat treated without removing it from the welding machine, makes possible consistently strong welds.

HOW IT'S DONE

The weld is made in the normal manner. When its temperature has dropped to approximately 200 to 300 degrees above room temperature, current is passed through again. Adjustment of this current, which differs in both time and magnitude from that used in the welding, is provided by the tempering attachment.

The additional heating, or tempering, materially increases the toughness and ductility of the weld.

FOR ADDITIONAL FACTS

Wherever medium-carbon, low-alloy, or high-alloy steels must be joined, spot welders with G-E tempering control will give a product of maximum strength. For further details about this control, get in touch with your resistance-welder manufacturer or our nearest office. Ask for our Bulletin GEA-4201. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

● ● ●

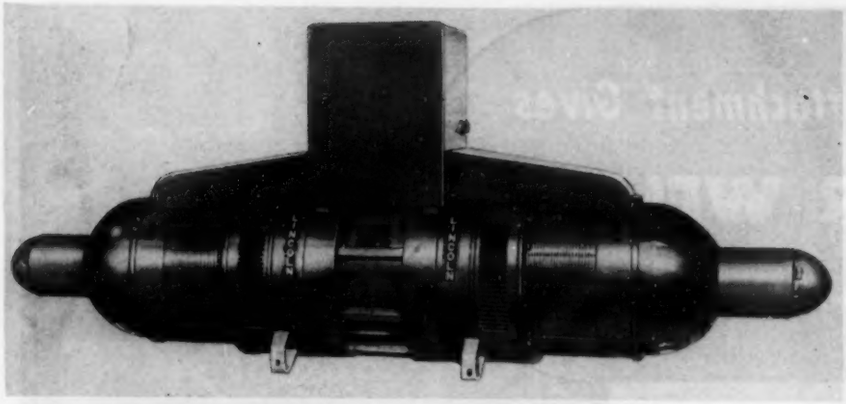
In this strength test, the American-La France-Foamite 100-foot, all-steel fire-fighting ladder supports weights totalling 3,200 pounds at an angle of 60 degrees.

● ● ●

RESISTANCE WELDING CONTROL

8960

GENERAL ELECTRIC



1200-AMP. WELDER

A new welder of 1200 amp. comprising two 600-amp. generators, close coupled to an a.-c. induction motor and equipped with complete motor control is announced by The Lincoln Electric Co., Cleveland, Ohio, for use with the company's recently introduced "Lincolnweld" Process of automatic metallic shielded-arc welding. The unit is of arc-welded steel, drip-proof construction and is completely wired, ready for connection to the a.-c. power source and to the "Lincolnweld" head of the stationary, self-propelled carriage or tractor type.

Generators are of the variable voltage type with completely laminated magnetic circuits (frame and pole pieces) and equipped with interpoles. They require no external reactance or stabilizer. Armatures are insulated with glass and mica insulation to permit sustained operation at high loads. Interpoles are insulated with asbestos. Series coils are so liberally designed that Class A insulation only is needed. Absence of intermediate taps in series coils makes them compact and well ventilated. Arrangement of shunt and differential series fields same as in Lincoln S.A.E. single-operator generators to assure arc stability.

Motor is of the squirrel cage induction type arranged for Y-delta starting. Size of motor is ample for heavy overloads. Connection is for 220, 440 or 550 v., three or two phase, 60 or 50 cycles.

One 125-v. exciter assures ample power for both generator field excitation and for operation of the d.-c. control circuits of the Lincolnweld equipment and the travel carriage and tractor motor when used. The other, a 35-v. exciter, provides the auxiliary power for the wire feeding motor in the head. Exciters and main welding generators are electrically separate so as to improve welding performance and reduce upkeep costs. Exciters are direct connected on end of each generator. Exciter armature mounted by sleeve construction on same shift as generator armature.

The front part of the control cabinet contains the d.-c. generator output terminal connections and a terminal board for readily making connections from the automatic equipment to the two exciters and the welder field circuit.

Designated as SA-1200, this new welder weighs 3200 lb. and is designed for easy mounting by means of 4 feet two on each side.

WELDER IS BOON TO FARM EQUIPMENT DEALERS

The farmer's "New Hired Man" goes to work for Joe Benline near Chardon, Ohio. One of his jobs is equipping old farm implements with new wheels for pneumatic tires. With power for the welding arc supplied by his light-weight, 200-amp., air-cooled gasoline engine-driven welder (the farmer's "New Hired Man") seen at rear in accompanying view, Benline applies the finish welds with $^{5}/_{32}$-in. shielded arc electrode for mild steel to fuse the spokes to a

Courtesy Lincoln Electric Co.

new rim for a pneumatic tire. In this case, the hub and spokes were cut out of a discarded farm wagon wheel, but according to Benline, practically any old steel-rimmed wheel can be salvaged for this purpose. (This job can be done by farmer himself if he has an arc welder, but usually the Implement Dealer is best equipped to take care of jobs of this kind.)

STEEL IN THE WAR

The war role of a basic American industry and its largest producer is fully revealed for the first time in an important new book, *Steel in the War*, a now-it-can-be-told story of an industrial accomplishment which contributed so much to the victory of the United Nations in World War II. It is the war story of United States Steel Corporation.

Steel in the War, published by United States Steel, assembles for the first time facts and figures which measure the importance to the national security of this basic metal. It leaves the reader with an impression of industrial energy that, often taken for granted, is nonetheless a prime factor in our national development. The book, which is generously illustrated, has been made available to thousands of libraries where it may be used as an industrial reference volume.

To back up the colossal industrial effort of the United States and its Allies, and at the same time meet essential home front needs, the American steel industry increased its annual production 70% over 1939, and produced the gigantic total of 467,000,000 tons of steel in five years, ending July 31, 1945.

Eye-opening are the accomplishments of United States Steel and the steel industry as revealed in *Steel in the War*. Perhaps for the first time the average person will realize, for instance, how perilously close we came to not being able to produce enough alloy steels to meet our war demands. When foreign sources of critical alloying materials were cut off by enemy action, metallurgists worked feverishly and came up quickly with the now-famed National Emergency Steels, new alloys which were put into production to build the nation's fighting strength. The behind-the-scenes story of accomplishment of steel scientists discloses the importance of continuing research; and the part played by steel technicians in the war of steel, as well as the application of their research to production of products for peace.

The development of new production methods—prefabrication of ships sections, first introduced in a U. S. Steel shipyard, the new bomb-spinning process which speeded output of heavy bombs, new welding techniques which provided greater protection for the men who manned our tanks—is recited in this diary of war production.

Employment Service Bulletin

SERVICES AVAILABLE

A-519. Young man presently employed as a welding engineer seeks wider scope and opportunities for his abilities. Thoroughly experienced in all welding and burning processes normally encountered in heavy fabricating and material salvaging. Background includes practical welding experience. Desires position in welding supplies sales field. Will be an asset to the manufacturer or supplier who requires a sales engineer with a good welding background to act as a trouble shooter in the field. Prefers Eastern Territory, but will consider other locations.

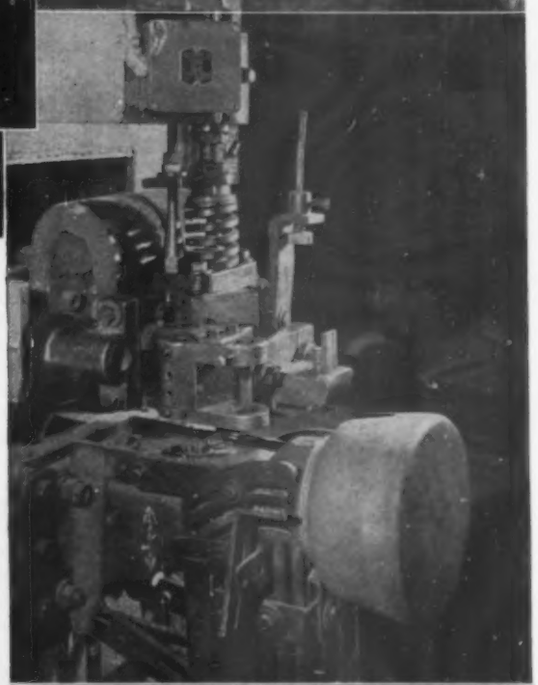
POSITION VACANT

V-189. Assistant in metallurgical research and development, field of electric arc welding. Location, within one hour travel time of New York City. Required, *young Metallurgist* with experience in research and development, preferably in the field of electric arc-welding or a *young Welding Engineer* with research and development background.

Durable Steelware

This Federal PATM-3 Press Tube Welder is projection welding handles on percolators at the rate of about 500 per hour. (See fixture upper right). Previous operation, on a companion Federal, attached the spouts.

This fixture can be adjusted to fit more than one size of handle. The Federal resilient head, combined with air-operation, assures smooth operation, fast follow-up.



Parts of this fixture are adaptable to other operations, other shapes. Here, tabs for tea-kettle bail are projection welded to body. Change-over to setup for attaching spouts takes but a few minutes.

ety of shapes these welders have handled continuously since 1937.

Whether you make houseware or houses, toys or tractors, you are today faced with certain increasing costs . . . It is important that you investigate possible applications of Federal Resistance Welders to assure utmost efficiency in YOUR processing.

Federal makes every variety of resistance welder . . . Spot, projection, seam, roll spot, flash or portable gun types . . . Federal engineers also design machinery combining the features needed to fit special production. To attain maximum metal fabricating efficiency, employ Resistance Welding. To get the most from Resistance Welding . . . be sure it's by

Federal

AND WELDER COMPANY

206 DANA STREET • WARREN, OHIO

ABSTRACTS OF CURRENT WELDING PATENTS

Prepared by V. L. Oldham

Printed copies of patents may be obtained for 10¢ from the Commissioner of Patents, Washington, D. C.

2,393,653—Welded Ship; George Pamphilis, *Inventor*, Hoboken, N. J. Assigned to Argonant Engineering Corp. *4 claims.*

This patent covers a mechanical reenforce used in a welded ship having an interior frame welded to hull plates of the ship.

2,393,662—Control System for Welding Heads; Joseph Skuhrovec, *Inventor;* Cleveland, Ohio. Assigned to Una Welding, Inc. *8 claims.*

The welding machine disclosed has a work support and an electrode movable toward and away from the work by a feed mechanism driven through a differential. One of the two drivers for the differential is a shunt wound motor having a main field winding, and an auxiliary strengthening field connected directly across the arc.

2,393,742—Welding Electrode Holder; Edward Brazitis, *Inventor;* St. Clair Shores, Mich. *11 claims.*

Brazitis' electrode holder basically comprises two electrode-holding jaw members, at least one of which is a conductor, and a pin for connecting the jaws for pivoted movement. The pin is insulated from the conductor jaw member.

2,393,830—Electrode Holder; Albert H. Smith, *Inventor;* South Gate, Calif. *2 claims.*

In this holder, an elongated tubular shell has a series of crotches for seating a welding rod near the outer end of the shell. The crotches are disposed at an angle to the vertical and have opposed edges parallel to the shell axis. A spring-urged rod is provided to hold a weld rod in the crotches while a lever is provided to move such rod for weld rod release.

2,394,004—Apparatus for Welding Seams; Harold T. Odquist, *Inventor;* Yonkers, N. Y. Assigned to American Can Co., New York, N. Y. *2 claims.*

This patent relates to apparatus for welding sections arranged in a given pattern and requiring different welding treatment. In the welding electrode circuit, conducting ignition, and firing tubes are provided together with a phase-shifting circuit for effecting a variable but continuous heat input while relative seam and electrode movement occurs. Switch elements in the welding circuit vary the heat input in the welding cycle by controlling the phase-shifting circuit; while further means, operated by the means relatively moving the electrode and seam, control the switch elements to vary the heat input in a pattern corresponding with the welding requirements of the seam sections.

2,394,136—Welding Glove; Robert Bakke, *Inventor;* Minneapolis, Minn. Assigned one-half to Gudrun Elizabeth Swahn, Minneapolis, Minn. *2 claims.*

In the patented glove, a preformed, nonbendable fireproof shield is attached to the sides of a standard welder's glove and extends forwardly therefrom beyond the finger tips. A fireproof shield of similar material also is attached to the cuff portion of the glove.

2,394,204—Electrode Holder; Earl A. Randall, *Inventor;* Kansas City, Mo. *9 claims.*

Randall's holder has a spring for moving the holder's jaws apart, a second spring for moving the jaws toward each other and means for selectively loading the latter spring. An adjustment device is provided for the selective loading means.

2,394,349—Gas Torch; Peter Wilson *Inventor;* Vancouver, British Columbia, Canada. *7 claims.*

The torch body has a jet and a nozzle with an ignition chamber therebetween and an abrasive igniter in such chamber. The ignition chamber is normally closed off from the jet and nozzle but such closure is removable. Means for actuating the igniter when the closure is being returned to normal position also are provided.

2,394,388—Shield for Welders' Helmets; Arthur Krogel, *Inventor;* Spokane, Wash. *3 claims.*

The patented shield includes a visor for the window of a welder's helmet and it has arms extending downwardly from its edges for securing it to the edges of a window in a helmet.

2,394,550—Coated Electrode; Cyril D. Jensen, *Inventor;* Annapolis, Md. *9 claims.*

A tubular coated, ferrous electrode for underwater cutting is provided in the patent. The coating on the electrode comprises, by volume, from 5 to 7 parts of resin base material in lacquer form, which is fundamentally a polyvinyl chloride; and from 3 to 5 parts of arc stabilizing material from the group of lime, talc, barium carbonate and iron oxide. The coating is thick enough to have a slower burning rate than the electrode.

2,394,626—Welding Apparatus; Alexander C. McCann, Kearny, and Thomas E. Walsh, Bayonne, N. J., *Inventors.* Assigned to Western Electric Co., Inc. *6 claims.*

The welding apparatus disclosed has an electrode adapted to support a member having a plurality of articles carried thereby, a movable electrode and means cooperating with the articles to guide them and the member into welding positions. A further element is provided for movement by the movable electrode into engagement with the articles for welding them simultaneously to the member.

2,394,775—Metal Cutting Apparatus; Gunnar Hans Hilstrom, East Weymouth, and William E. Westland, Quincy, Mass., *Inventors.* Assigned to Bethlehem Steel. *10 claims.*

This cutter has a holder operatively connected to a movable carriage and a support for engaging the surface of a member. A tipped means is mounted on the holder with the tip extending through a recess in the support which has a heat-insulated journal thereon adjacent the tip.

2,394,822—Metal Strip Coil Welding Machine; Alfred Teplitz, *Inventor;* Pittsburgh, Pa. Assigned to Carnegie Illinois Steel Corp. *3 claims.*

A carrier is provided for reciprocating radially of a coil of metal strip positioned by the apparatus. The carrier mounts a member carrying spaced spot-welding electrodes, which member may be rotated through an arc with relation to the carrier so as to position the spot-welding electrodes spaced circumferentially of the coil. Means for moving the carrier into engagement with the coil complete the machine.

2,394,877—Arc Welding Rod Holder; Harold W. Schottenberg, Youngstown, and John J. Volosin, Poland, Ohio, *Inventor. 1 claim.*

The holder has two holding members which are urged into holding relation by a spring. The holding members have downwardly curved jaws with means on their opposing surfaces for engaging the welding rod.

2,395,053—Welder's Shield; George G. Landis, *Inventor;* University Heights, Ohio. Assigned to The Lincoln Electric Co., Cleveland, Ohio. *6 claims.*

The shield disclosed has a box-like extension of light-impervious material over an opening in the shield. A semiopaque lens is mounted in the forward wall of the extension and a more transparent lens is positioned in an opening in the lower wall of the extension.

2,395,059—Welding Apparatus; Howard I. Morris, *Inventor;* Lakewood, Ohio. Assigned one-third to Carl M. Yoder and one-third to Harvey O. Yoder, Lakewood, Ohio. *12 claims.*

In this patent, current rectifying means, a support rotatably carrying a sectional frame, and a transformer secured to one section of the frame and having its secondary electrically connected to the rectifying means, are provided. The other sections of the frame are conductor devices electrically insulated from each other and the

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HAS THE WELDING SUPPLIES YOU NEED

A welding rod or flux that's good for one job may be "bad medicine" for the next. No single product can meet every requirement—true of any metal, ferrous or nonferrous. That's why it's wise to consult an expert whenever you have an unfamiliar joining problem.

Alcoa has developed the welding alloys and fluxes you'll need for any aluminum joining job. Fabricating procedures have been worked out to give most dependable results. Data on these materials and methods are yours for the asking.

For help on joining problems and for prices on welding and brazing materials, call the near-by Alcoa sales office. Or write:
ALUMINUM COMPANY OF AMERICA,
1933 Gulf Bldg., Pittsburgh 19, Pa.

For best results, specify these ALCOA products

GAS WELDING WIRE

Alcoa 2S—commercially pure
Alcoa 43S—5% silicon
In coils or in 36-inch straight lengths

SIZE DIAMETER	FEET PER POUND	SIZE DIAMETER	FEET PER POUND
1/16	270	5/32	45
3/32	120	3/16	30
1/8	70	1/4	17

METAL ARC WELDING ELECTRODES

Alcoa 2S or 43S core wire
In 14-inch lengths—2 pound heat sealed packages

Size	1/8" Dia.	5/32" Dia.	3/16" Dia.	1/4" Dia.
Rods per lb.	32	23	17	10

ALCOA No. 22 GAS WELDING FLUX

8 oz. jar 1 lb. jar 5 lb. jar 50 lb. drum 150 lb. drum

ALCOA FIRST IN ALUMINUM

ALCOA ALUMINUM

first-mentioned frame section, and electrically connected to the current rectifying means which is mounted between the first mentioned, and the other frame sections. Electrodes are fixedly related and electrically connected to the conductor devices.

2,395,062—HIGH-FREQUENCY ARC WELDER; Clayton P. Nielsen, *Inventor;* Chicago, Ill. Assigned to Mid-States Equipment Co., Chicago, Ill. *3 claims.*

This patent relates to the impression of a high-frequency current on the secondary current of a welding transformer. The primary of a Tesla coil of special construction is connected to the secondary of a high-frequency transformer the primary of which is supplied with power. A spark condenser is connected in the circuit of the primary of the Tesla coil while a spark gap is across the secondary of the high-frequency transformer. The secondary of the Tesla coil is in the welding circuit of the secondary of the welding transformer. A by-pass condenser then completes the apparatus, which condenser is connected over the secondary of the welding transformer to prevent high-frequency current from entering it and increase the amount of high-frequency current available for the welding operation.

2,395,213—ELECTRODE HOLDER; Philip L. Bourque, *Inventor;* Detroit, Mich. *4 claims.*

This holder includes a tubular handle formed of dielectric material. A male screw thread member is carried in the bore of the handle and it engages with a female member that has two arms extending from the handle for electrode engagement. Rotational movement of the female member with relation to the handle varies the relative positions of the arms.

2,395,214—ELECTRODE HOLDER; Philip L. Bourque, *Inventor;* Detroit, Mich. *2 claims.*

The disclosure of this patent is somewhat similar to that of patent 2,395,213 and specifically relates to the connection of a metallic casing member to the casing made of dielectric material.

2,395,228—ELECTRODE HOLDER; Herbert N. Lininger, *Inventor;* San Francisco, Calif. *3 claims.*

Lininger's holder provides a chuck having movable jaws for welding rod engagement, and a jaw-actuating stem secured to the chuck. An insulating sleeve is positioned around the chuck and stem, which connects to a conductor.

2,395,343—WELDING ROD HOLDER; Richard K. Morse, *Inventor;* Muskegon, Mich. Assigned to The Kaydon Engineering Corp. *8 claims.*

In this patent, a tubular member having a threaded bore receives a threaded stem which carries a clamping hook and a cooperating sliding clamping pin eccentric to the stem. A follower is carried by the stem and it fixes the clamping pin in position whereby the clamping hook is drawn toward the clamping pin when the stem is drawn into the tubular member.

2,395,358—WELDING ROD HOLDER; Lee L. Turney, *Inventor;* Spring Lake, Mich. Assigned to The Kaydon Engineering Corp. *7 claims.*

This patent covers a welding rod holder very similar to that of patent 2,395,343.

SECTION ACTIVITIES

CANADIAN

The Montreal Chapter of the Canadian Welding Society held its fifth meeting of the season on February 18th in the Montreal Technical School. R. A. Dunn, of the Canadian Liquid Air Co. Ltd., discussed the "Mechanics of Oxy-Acetylene Precision Cutting."

The Hamilton Chapter held its sixth meeting of the 1945-46 Series on March 5th at McMaster University. L. Jehu, Jr., of the Dominion Bridge Co. Ltd., Lachine, spoke on the "Design of Structures for Welding."

CHATTANOOGA

The regular March meeting was held February 28th at the Chattanooga Golf and Country Club. J. H. Cooper, Chief Sales Engineer for The Taylor-Winfield Corp., Warren, Ohio, spoke on "Resistance Welding Applications." The talk was illustrated by slides which showed a few of the uses which resistance welding served during wartime and many of its possible peacetime applications.

CLEVELAND

On February 6th, at a Dinner Meeting, the Executive Committee of the Cleveland Section was host to various high ranking officers of the AMERICAN WELDING SOCIETY. The officers present were: Wendell F. Hess, President; Miss M. M. Kelly, Secretary; H. O. Hill, First Vice-President; G. N. Sieger, Second Vice-President; O. B. J. Fraser, Treasurer; B. L. Wise, District Vice-President, District No. 4; W. Spraragen, Editor, THE WELDING JOURNAL. The Cleveland members present were as follows: Ross J. Yarrow, Chairman; J. F. Wagner, Secretary-Treasurer; Miss Nancy Flinta, Mr. Wagner's Secretary; Kent C. Thornton, Mike Shane, Robert Kriz, Franklin J. Maine, Ed Scott, John Morrill and Arthur Portz.

The dinner was a huge success and the informal meeting which followed brought out various phases and problems of the local sections and the need for a lengthy round-table discussion at our next National Meeting. It was brought out that the business of a local section should be thoroughly aired and those people not fully informed should be instructed and educated along this line.

Another matter discussed was that on February 1st, experts from the Cleveland Section visited Detroit along with experts from the Toledo Section. A Weldformation Quiz Test was held and the winner, Cleveland, received an oil can. Various members who were present at that contest were in high praise of this type of meeting and suggested that some such meeting be held at various local sections to break up the straight technical lectures which are usually held.

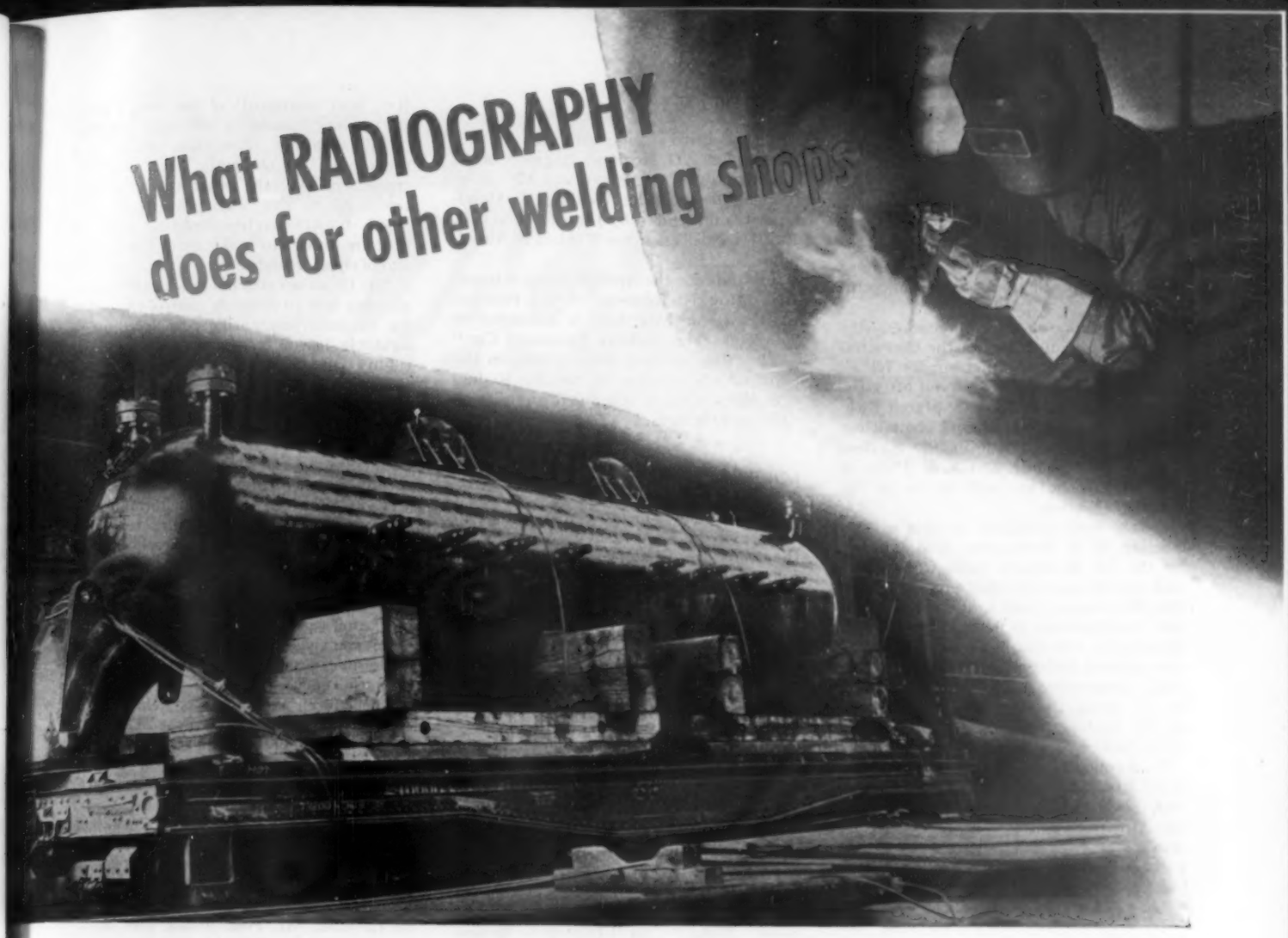
Another point which came up for discussion was the success of the May Conference which the Cleveland Section holds annually.

The meeting adjourned at 10:30 P.M. with a general agreement that further work must be done in educating the various local sections in the proper way to conduct their meetings and carry on their various other functions.

C. B. Voldrich, Supervisor of the Welding Research Division of Battelle Memorial Institute, Columbus, Ohio, spoke at the February meeting, held on the 13th, on "The Heat-Affected Zone in Steel Weldments." Mr. Voldrich's talk dealt with the cracking and ductility problems in the welding of high strength and structural machine steels on which Battelle has been doing some recent research work.

Speaking at dinner, Lieut. Col. C. Merrill Barber, now on terminal leave with the Corps of Engineers and prominent consulting engineer in Northeastern Ohio, spoke on "American Airfields in Europe." Mr. Barber spent 31 months in Europe building airfields for the Army.

The Cleveland Section educational



What RADIOGRAPHY does for other welding shops

...it can do for YOURS

SINCE the early 1930's, boiler codes have specified that welded joints on certain high-pressure equipment would be acceptable if radiographed to provide evidence of internal soundness of the weld.

Radiography thus opened a new field for fabrication by welding . . . by helping to show engineers that welds, backed by radiographic proof of soundness, are practical, strong, economical . . . suitable for many kinds of fabricated products.

Radiography has also created a market for welding in foundries, for repairing castings that are internally unsound . . .

New welders do better work, and do it quicker, when radiography shows how their technic can be improved. Moreover, radiographic inspection of production weldments helps maintain consistently high quality.

Complete, non-destructive radiographic examination provides a record for reference and study . . . and is often less costly than other methods.

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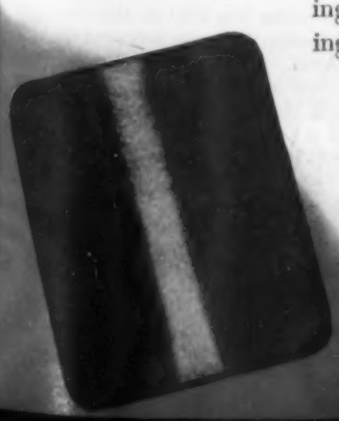

Radiography

another important function of photography

Kodak

course continues its interest and attendance. At a recent meeting Cecil Peck of the Cecil C. Peck Co. spoke on "Designing Jigs and Fixtures" and on January 28th the Cleveland Section enjoyed a most interesting field trip to the electrode manufacturing plant of Whitey Maurath.

An educational course on resistance welding is held every Tuesday evening at the John Huntington Polytechnic Institute.

The month of March marked the twenty-fifth anniversary of the Cleveland Section, and a free buffet supper for all members and guests was served after the regular technical meeting on March 13th.

Of the original officers and committees that founded the Cleveland Section, Hugh Dyar of Linde, and A. F. Davis of Lincoln Electric are still active in the Cleveland Section.

As the main technical speaker at this meeting, R. F. Helmkamp, field engineer for the Air Reduction Sales Co. for the past twenty-six years, spoke on the "Electric Bloodhound" and a number of other new developments in flame cutting. Mr. Helmkamp, who has been active in maintenance and production work in the aircraft, automotive and railroad industries for a number of years, covered such items as the flame cutting of stainless steels, Billet Nicking, etc.

As a coffee talk, the Cleveland Section heard from adventurer Hollie C. Williams who spoke on "Mysteries and Beauties of the Great Southwest." Mr. Williams, who is a traveler and mountain climber as well as an engineer, gave a very interesting talk illustrated with Kodachrome slides.

COLUMBUS

The March meeting of the Columbus Section was held on the 8th at the Southern Hotel. "Silver Brazing Alloys in Industry" was presented by a representative of Handy & Harman.

DETROIT

On February 1st, the Detroit Section inaugurated the first of a series of "Quiz" programs. Guest members from the Cleveland and Toledo Sections were as follows:

Cleveland: Ross Yarrow, Chairman, E. B. Pederson, J. F. Vickery, Thomas J. Crawford.

Toledo: Edwin Nafzger, Chairman, A. E. Colwell, W. T. Hill, C. M. Richardson.

Members of the Detroit group were: Wm. N. Pfander, Foster Woodward, Neil Wheeler, S. B. Rowland.

Questions prepared by a committee from those sent in by members were presented to each group and after a lively session Cleveland was found to have received the greatest amount of applause. The trophy was presented by Vice-President G. N. Sieger.

The Saginaw Valley Division held its sixth meeting of the season on February 14th at the Fischer Hotel, Frankenmuth, Mich. Harold M. Macauley, Vice-President of the Wolverine Gas Products Co, presented an interesting and stimulating talk on "Magic with Liquid Oxygen."

HARTFORD

The February 21st meeting was addressed by G. O. Hoglund, Engineer of the Aluminum Co. of America. Mr. Hoglund's talk on "The Welding of Aluminum was illustrated by three films on Gas, Electric and Resistance Welding of Aluminum.

The date for the April meeting is tentative. Roy F. Johnson, of the Pullman Standard Car Mfg. Co., is scheduled to speak on "The Railway Passenger Car."

The May meeting will be held on the 23rd. A. N. Kugler, of the Air Reduction Sales Co., is scheduled to talk on "Jigs and Fixtures."

LOUISVILLE

The February meeting featured J. L. Filbert of the Page Steel & Wire Div. of the American Chain & Cable Co. Mr. Filbert spoke on "Chrome and Chrome Nickel Steel Welding" and its increased use due to wartime developments. Fred Kemper of the National Manufacturers Agency arranged the program.

The coffee speaker was Morris D. Bement, Executive Director of the Committee for Kentucky, who gave a talk on "Wake Up, Kentucky!" a timely and interesting subject.

MARYLAND

Dinner at the Engineers' Club preceded the February 15th meeting of the Maryland Section. J. M. Diebold, of General Motors, spoke on "Fusion Welding of Sheet Metal." Mr. Diebold's lecture showed what can be done with manual arc welding with rapid production methods and procedure control. A film, "Controlling Distortion," was shown through the courtesy of The Lincoln Electric Co.

MICHIANA

There is considerable interest in welding and welding problems as was evidenced at a recent meeting of the Michiana Section which has a membership in the South Bend manufacturing area. This takes in representatives from the surrounding cities and towns of northern Indiana and southern Michigan.

John Grodrian, Chief Metallurgist of the Bendix Products Division, spoke on the weldability of transformation hardening steels.

The speaker explained the Lehigh University system of evaluating the weldability of steels.

Following presentation of this system, several other research works of merit were explained. One of these showed that hydrogen gas pressure from hydrogen diffused into the metal from the electric arc welding operation at high temperatures and later forced out of solution as the metal cools exerted enough stress to cause cracks. Another demonstrated that two materials quite similar in most respects ordinarily considered in evaluating weldability were found quite different in crack sensitivity during welding. It was found that the prior thermal history (i.e., heat treatment) of the metals prior to welding caused a different internal metal structure observable under the microscope which made one material crack sensitive, the other crack insensitive. When this was properly understood, both materials could be given a heat treatment to make them insensitive and of equal weldability.

Mr. Grodrian concluded his talk by explaining how to properly control the welding of steels ordinarily considered nonweldable because of their great susceptibility to cracking. This consists of using a preheat of approximately 600–800° F. followed by a postheat in the same approximate temperature range. By studying a time-temperature-transformation curve of the steel to be welded, a certain temperature range can be observed where the rate of transformation is a maximum. By applying this temperature for postheating, the steel can be made to transform fully at an elevated temperature to a structure relatively crack insensitive. The time for transformation varies with each individual steel and is somewhat longer than shown on the isothermal time, temperature and transformation curve.

The March meeting was held on the 15th at the Bendix Legion Post 284, South Bend, Ind. The speaker of the evening was J. Pollei, Welding Engineer for the A. O. Smith Corporation, Milwaukee, Wis., whose subject was "Pressure Vessel Welding." The A. O. Smith Corp. has had extensive experience in welding all sorts of large and small structural members, and pressure vessels of all types have been fabricated by them. With this background, Mr. Pollei's talk was of extreme interest to all those present.

MILWAUKEE

The regular meeting of the Milwaukee Section was held on February 22nd at the Ambassador Hotel. After-dinner program consisted of a movie, "Eternally Yours," the story of wrought iron.

The welding address was presented by John B. Tinnon, Executive Vice-President, Metal & Thermit Corp., New York. Mr. Tinnon reviewed the history of Thermit Welding and the development of the process for such work as rail welding and repairing of equipment. He also discussed the possibilities of employing Thermit Welding for the fabrication of heavy parts as indicated by the work done during the war in the shipyards.

Mr. Tinnon's talk was accompanied by a colored movie film on the subject.

NEW JERSEY

February meeting was held on the 19th at the Essex House, Newark, preceded by dinner as usual. "Information Please" Session with Robert Pursell of the Worthington Pump & Machinery Corp., Newark, as chairman.

Illustrated talk was made by Charles W. Bryan, Jr., Vice-President of the Federal Shipbuilding and Dry Dock Co., Kearny, N. J., on "Some Observations on the Selection of Welding in Ship Design and Construction."

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RACO 8011	E- 8011
RACO 9011	E- 9011
RACO 10011	E-10011
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RACOLLOY 25-12 CB	309+CB
RACOLLOY 25-20	310
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SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

A film was shown through the courtesy of the Navy Department.

NEW ORLEANS

The Louisiana Section has announced a change in its name to the New Orleans Section.

NEW YORK

The February 15th meeting of the New York Section was a joint meeting with the New York Metropolitan Section of the Society of Naval Architects & Marine Engineers. The meeting was addressed by R. F. Grambow, Naval Architect of the Marinship Corp., Sausalito, Calif. His subject was "Creating a Shipyard for Welding Construction." E. P. Trask of Gibbs & Cox, New York, was Technical Chairman for the evening.

Mr. Grambow introduced his talk by the showing of a sound color motion picture recording the construction progress of the yard. An interesting point brought out by the movie was that construction of ships proceeded almost simultaneously with the construction of the yard itself. Following the movie, Mr. Grambow discussed the advantages of being able to start from scratch and build a shipyard particularly suited for the production of ships by the extensive use of welding. This was in contrast to the difficulties experienced by older yards in adapting their existing facilities to the most efficient use of welded construction.

Because of their common interest, a large number of members of THE WELDING SOCIETY and the Naval Architects attended the meeting. H. O. Klinke is Chairman of the New York Section of the A.W.S. and J. A. Livingston is Chairman of the New York Metropolitan Section, S.N.A.M.E. The New York Section has found that joint meetings are very popular with their members because of the fact that they bring them information on widely diversified applications of welding.

The New York Section plans an inspection trip to the laboratory of Metal and Thermit Corp. at Woodbridge, N. J., on April 27th. The committee in charge includes Charles Kandel and J. L. Cahill of the New York Section and Charles Cooper of Metal and Thermit.

NORTHERN NEW YORK

This Section was host to the Coordinated Societies of the Schenectady Engineering Council on January 24th at a meeting held at the Hotel Van Curler. About fifty people were present to hear a very excellent presentation of a most interesting subject, "The Pullman Car of the Future" by Roy Johnson of the Pullman Standard Car and Mfg. Co. The lecture was illustrated with slides and covered the old as well as the new railway passenger cars. The use of resistance and arc welding was described in detail. A lively period of questioning the speaker and A. M. Unger, of Pullman, followed the prepared lecture and brought out many interesting points regarding railway cars.

The third meeting of the season was held on February 28th. The speaker was Commander Arthur E. Poole, graduate of Rensselaer Polytechnic Institute, and now with the Bureau of Yards and Docks of the U. S. Navy. Commander Poole spoke on the details of welding drydocks and pontoons used by the Navy. His very interesting talk on the problems of welding heavy sections in the fastening together of drydock sections under field conditions, illustrated the type of difficulties the Navy encountered and overcame in providing the Fleet with docking facilities at the front line. An interesting film on sequence welding was also shown.

NORTHWEST

The February meeting held on the 14th was addressed by E. D. Morris, Manager, Unionmelt Service, Central Division, The Linde Air Products Co., Chicago. Mr. Morris' subject was on "Recent Developments in Unionmelt Welding Process." A short motion picture and slides illustrating the fundamentals and applications of the process were shown.

A. R. Lytle of the Union Carbide and Carbon Research Labs., Niagara Falls, N. Y., spoke at the March 5th meeting, on the subject "Oxy-Acetylene Pressure Welding." Motion pictures and slides illustrated the talk.

Also shown at this meeting through the courtesy of The Taylor Wharton Iron & Steel Co. was a colored film illustrating how gas cylinders are manufactured.

NORTHWESTERN PENNSYLVANIA

The regular monthly meeting of this Section was held on February 20th in the Y.M.C.A., Erie, Pa. "Flame Shape Cutting Processes" was presented by A. F. Chouinard, Manager of the Research and Development Department of the National Cylinder Gas Co. The talk was supplemented by many interesting slides showing details of flame-cutting processes.

PASCAGOULA

G. O. Hoglund, Chief Welding Engineer of the Aluminum Company of America, was the principal speaker at the regular monthly meeting of this Section held at the Country Club on March 12th. It was announced by the Program Chairman, Milton Forman, that members of the Section were fortunate to have the opportunity of hearing a national authority on the subject of aluminum welding. Mr. Hoglund's experience includes not only intensive research in his field but also the practical application of new technical methods. Films were shown to illustrate the lecture.

PHILADELPHIA

"Welding Problems that Reach a Consultant" was the subject of the address by Mr. T. Holland Nelson, Consulting Engineer, T. Holland Nelson Metallurgical Laboratory, Villanova, Pa., presented at the February 18th meeting held at the Engineers' Club.

The Philadelphia Section Education Committee is making a definite effort to cooperate with local engineering schools in order to make some contribution to their courses relating to Welding.

A meeting has been arranged between members of the Philadelphia Section and the Swarthmore College Engineering Faculty to organize a Student Section of the AMERICAN WELDING SOCIETY Swarthmore College. The University of Pennsylvania has well-established Student Sections of Civil, Electrical and Mechanical Engineering Groups and an AMERICAN WELDING SOCIETY Student Section would conflict somewhat with the activities of these groups. The Education Committee, in this case, has arranged to hold a regular Philadelphia Section Panel Discussion meeting at the University of Pennsylvania in which both the university students and local industrial men will participate.

Contacts have also been made with Drexel Institute of Technology in an effort to set up a program there.

PITTSBURGH

Fred L. Goldsby, Development Engineer, Chicago Bridge and Iron Co. of Chicago, presented a most interesting paper on "Design for Welding" before the Pittsburgh Section on February 20th. A very large attendance was present.

The paper covered points in designing for welding often overlooked by engineers. Slides were used to illustrate the talk.

Previous to the presentation a sound film was shown by J. S. Roscoe, Pittsburgh District Manager of The Lincoln Electric Co., depicting what goes on in welding joints and what can be done about it before it is too late. This is a very attractive and instructive film. It was made by the Walt Disney Corp.

PORTLAND, OREGON

The Portland Section announces the following changes.

Basil McLean, originally elected Vice-Chairman, was advanced to the chairmanship because of the resignation of Carl Lodell. Mr. McLean is local chief surveyor of the American Bureau of Shipping.

Leslie Poole, originally appointed Chairman of the Membership Committee, was elected Vice-Chairman to fill the vacancy left by Mr. McLean.

J. W. Donnelly of The Lincoln Electric Co. was appointed Program Chairman for the balance of the season.

Vincent Shanahan, Welding Engineer with the Electric Steel Foundry Co., was selected Membership Chairman to replace G. L. Revell who has been transferred from this Section.

PUGET SOUND

The February dinner meeting held on the 26th at the Engineers' Club was addressed by George M. Huck, Manager, Alloy and Tool Steel Sales, Bethlehem Pacific Coast Steel Corp., who spoke on "Weldability of Low Alloy Steels."

This presentation was followed by the

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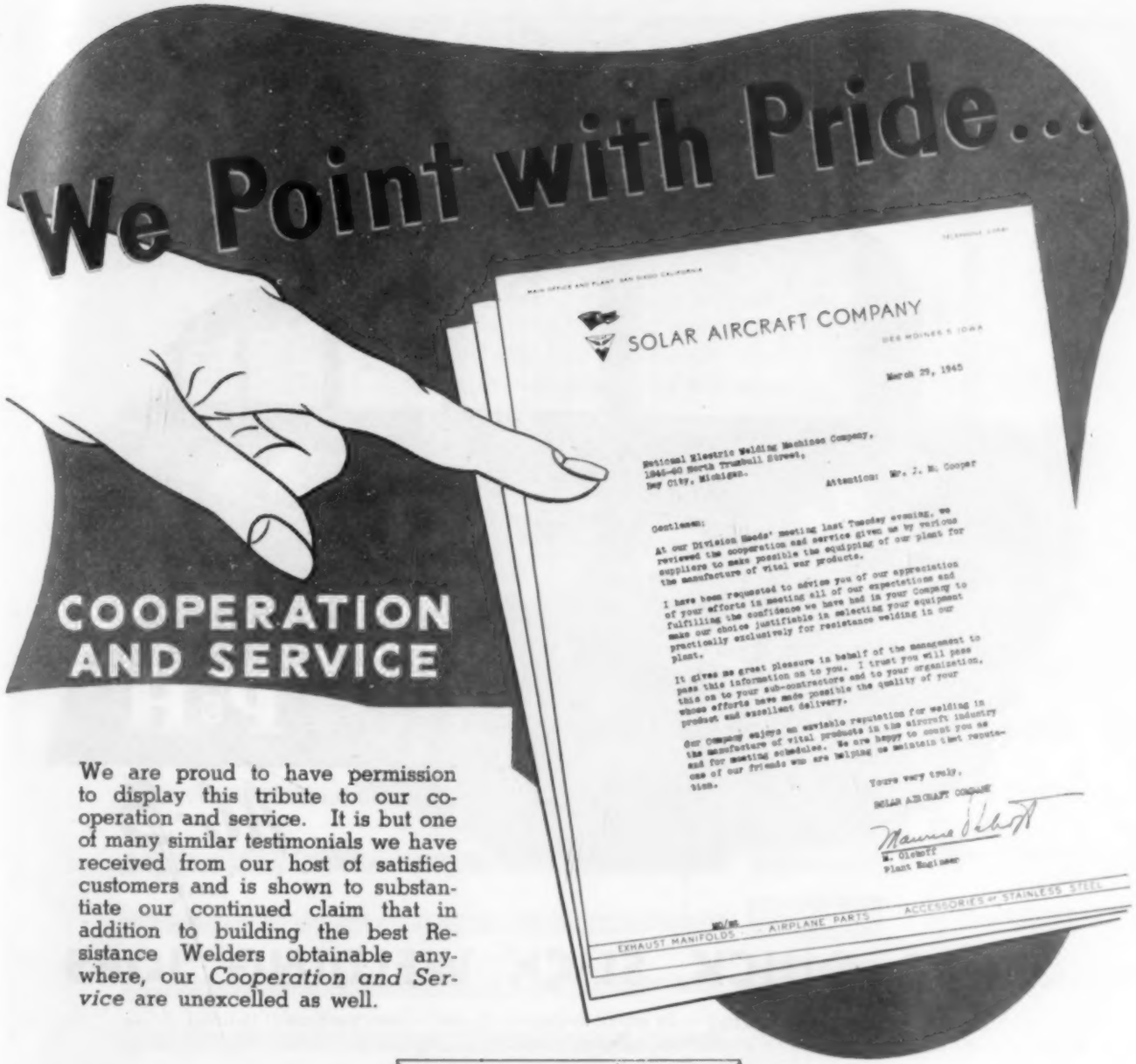
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March 29, 1945
National Electric Welding Machines Company,
1845-60 North Trumbull Street,
Bay City, Michigan.
Attention: Mr. J. M. Cooper
Gentlemen:
At our Division Heads' meeting last Tuesday evening, we reviewed the cooperation and service given us by various suppliers to make possible the equipping of our plant for the manufacture of vital war products.
I have been requested to advise you of our appreciation of your efforts in meeting all of our expectations and fulfilling the confidence we have had in your Company to make our choice justifiable in selecting your equipment practically exclusively for resistance welding in our plant.
It gives me great pleasure in behalf of the management to pass this information on to you. I trust you will pass this on to your sub-contractors and to your organization, whose efforts have made possible the quality of your product and excellent delivery.
Our Company enjoys an enviable reputation for welding in the manufacture of vital products in the aircraft industry and for meeting schedules. We are happy to count you as one of our friends who are helping us maintain that reputation.
Yours very truly,
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Plant Engineer
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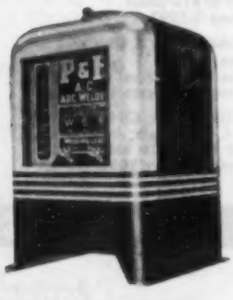

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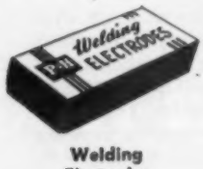

Welding Electrodes

Welding Positioners

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Electric Hoists

showing of a motion picture, entitled "Streamlined Steel."

A most instructive and enlightening evening was enjoyed by the seventy members and guests present.

ROCHESTER

The monthly meeting of this Section was held on March 7th in the Lower Strong Auditorium, University of Rochester. Dinner at the Powers Hotel preceded the meeting. Paul W. James of The Lincoln Electric Co., Syracuse, N. Y., spoke on "Automatic Welding." This was a very fundamental talk on the various types of automatic arc-welding equipment and their applications.

A movie, "Mexico," was shown.

SAINT LOUIS

A joint meeting with the Engineers' Club, was held on February 14th at the Engineers' Club. This being a joint meeting, the session was formally opened by Jules Beebier, President, who in turn introduced the Section's Vice-Chairman, Gayden Derickson, who presided.

The principal speaker of the evening, A. R. Lytle of the Union Carbide and Carbon Research Laboratories, Inc., lectured on the history of forge or pressure welding. He detailed clearly the technical fundamentals of this "now named" Solid Phase Welding, and supplementing with slides and sketches, revealed practical applications of the process plus physical and metallurgical properties of weldments. In closing his lecture, Mr. Lytle had two films showing commercial application. The presentation was excellent and the 120 persons in attendance expressed their enthusiasm and interest with an active session of questions and discussion.

SAN FRANCISCO

The San Francisco Section has formulated an Educational Committee headed by Lt. Comdr. Robert S. Hale of 2232 North Point St., San Francisco 23, Calif.

The duties of this committee will be to cooperate with the universities and engineering colleges and schools in this area in an endeavor to stimulate their interest in the various branches of welding and welding research and possibly in the future to endeavor to have these institutions of higher learning give courses in Welding Engineers.

Other members of the committee are: Robert McCoy, Harold R. Myra, E. W. Bartz and Paul J. Cannell.

For its February 25th meeting, the San Francisco Section had the opportunity of visiting the San Francisco Naval Shipyard. This was made possible through the courtesy of Commodore Joseph W. Fowler, Shipyard Commander, and Captain Leonard C. Chamberlain, Shop Superintendent, and arrangements made by Members Lt. Commander Hale, Lt. Commander Kemper and Walter B. Danton, Welding Quarterman, at the shipyard.

San Francisco Section Dinner Group in the Officers' Mess of the San Francisco Naval Shipyard. Those at the Head Table, from Left to Right, Front Row, Are: Leo H. Berner, Chairman; Richard E. Labagh, Lt. Comdr. Robert S. Hale, Walter Darton, Mark Haines, Vice-Chairman

A group of 160 members and guests made the visitation. Meeting at the shipyard gate, the party was taken in buses provided by the Navy on a tour through the yard. Dinner was served in the shipyard cafeteria. Following the business meeting, the groups were escorted over a route which included the major drydocks, the submarine docks, and the main machine and welding shops. In addition, through the courtesy of the ships' officers, they were taken aboard one of the aircraft carriers. They were also shown demonstrations of special operations in the welding shop that had been arranged by Mr. Danton.

This proved a highly instructive and well-attended meeting. The Section is much indebted to the Naval Officers in charge, the active Naval group in the Section and its Program Committee for making possible this opportunity to see first hand the Navy's work in repair, conversion and overhaul in maintaining its fighting ships.

SOUTH TEXAS

Robert E. Bockrath, District Sales Manager, Magnesium Division of Dow Chemical Co., spoke on "Fabrication of Magnesium Alloys," at the February 15th meeting. Mr. Bockrath showed slides depicting welding procedures and various applications of welded magnesium parts. After the talk there was a demonstration of magnesium welding by the Heliarc process using argon gas.

SYRACUSE

The February meeting held on the 13th in the Main Building, College of Applied Science, Syracuse University, was addressed by J. B. Quigley, Graver Tank & Manufacturing Co., East Chicago, Ind. Mr. Quigley's subject was "Automatic Welding." Robert J. Greer, of the Carrier Corp., spoke on "Cost Comparison of City Gas, Oxygen and Oxygen-Acetylene for Flame Cutting."

TULSA

Howard N. Simms, Metallurgist with Black, Sivalls & Bryson, Inc., of Oklahoma City, was the guest speaker at the January 11th meeting. The subject of Mr. Simm's talk was "Jominy Tests Used to Indicate Pre- and Postheating on Alloy Welded Steel." His talk, illustrated with slides, proved most interesting.

D. H. Corey, Welding Engineer with The Detroit Edison Co., was the guest speaker at the February 8th meeting held in the Mayo Hotel. Mr. Corey's subject, "Welding of Piping for Severe Service Conditions," discussed items affecting the quality of the welded job such as the importance of proper equipment and its maintenance, proper clearances for working, etc. His talk also covered the advantages and disadvantages of the several possible methods of preheating and stress relieving, and some observations on field inspection.

R. T. Gillette, Research Engineer with the General Electric Schenectady Works Laboratory, spoke on the subject "Resistance Welding" at the March 8th meeting held in the Mayo Hotel. From Mr. Gillette's wide experience in the subject field, an interesting evening was enjoyed by all.

WASHINGTON

The February meeting was held on the 26th in the Potomac Electric Auditorium with Donald H. Corey, Welding Engineer, Detroit Edison Co., as speaker.

Mr. Corey is well known to THE WELDING SOCIETY as one of the pioneers and outstanding authorities in the welding of high-pressure piping. His talk and his manner gave every evidence of why he is held in such high regard.

The talk, illustrated with slides, traced the history of high-pressure pipe welding, described present practices, and discussed the recent problems arising from graphitization of carbon-molybdenum pipe and the methods design to overcome them. In the question period following the talk, one of the longest and most spirited in the Section's history, Mr. Corey was called upon to expand on a number of subjects, even including the manufacture of flange bolts.

In cooperation with a number of sections of other technical societies, the Washington Section is taking a leading part in trying to form an Engineers' Club in Washington. The interest is keen and there is every reason to believe that this organization will be established.

WESTERN NEW YORK

W. G. Theisinger, Vice-President of Lukens Steel Co., spoke on "The Fabrication of Pressure Vessels" at the January 25th meeting held at the 40 and 8 Club.

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WICHITA

The Witchita Section held its February meeting on the 6th at the Broadview Hotel. The speaker of the evening was D. H. Corey of The Detroit Edison Co. His subject was "Welding Pipe for Severe Conditions."

Mr. Corey discussed the design and use of backing rings in pipe welding and the failure of welded pipe installations working under high temperature and pressure due to graphitization at the heat-affected zone.

At the close of the lecture a discussion period was held and Mr. Corey answered questions from the floor.

YORK CENTRAL-PENNSYLVANIA

George N. Sieger, President and General Manager, S-M-S Corp., was the guest speaker at the March 6th meeting. Mr. Sieger's subject was "Resistance Welding."

List of New Members

February 1 to February 28, 1946

BOSTON

Lawless, John F. (B), Harnischfeger Corp., 526 Statler Office Bldg., Boston, Mass.
Nobrega, Alfred A. (C), Heywood-Wakefield Co., Gardner, Mass.

CANADA

Smith, Ralph Cyrus, Jr. (C), The Steel Co. of Canada, Ltd., Welding Wire Div., Garfield Office, Hamilton, Ontario.

CHICAGO

Kicherer, Harry J. (C), 2912 Lincoln Ave., Riverside, Ill.
Metzger, Raymond W. (C), Chicago Bridge & Iron Co., 1305 W. 105th St., Chicago 43, Ill.
Nerhus, Olav (C), 5523 Henderson St., Chicago 41, Ill.
Rode, William (C), 4849 W. George St., Chicago 41, Ill.
Swisher, Thomas H. (C), Edison General Electric Appliance Co., Inc., 5600 W. Taylor St., Chicago 44, Ill.
Williams, Gerald (C), 195 W. Quincy Rd., Riverside, Ill.

CINCINNATI

Martin, Robert F. (C), 3732 Andrew Ave., Cincinnati, Ohio.
Schaefers, Stanley J. (C), Fleischmann Transportation Co., 3280 Southside Ave., Cincinnati, Ohio.

CLEVELAND

Gier, Philip E. (B), Ferrotherm Co., 1861 E. 65th St., Cleveland 3, Ohio.
Grinnell, Albert A. (C), Thermogen Corp., 1326 Marquette, Cleveland, Ohio.
Kewley, Richard K. (C), Box 647, Canton 1, Ohio.
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Newman, Robert J. (C), 2631 Charney Rd., University Hts. 18, Ohio.
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McGhee, William H. (B), General Welding Co., 2137 W. 3rd St., Dayton, Ohio.
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LOUISVILLE

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Burks, Robert H., Jr. (B), c/o Cleaver Brooks Co., 326 E. Keexe Ave., Milwaukee, Wis.
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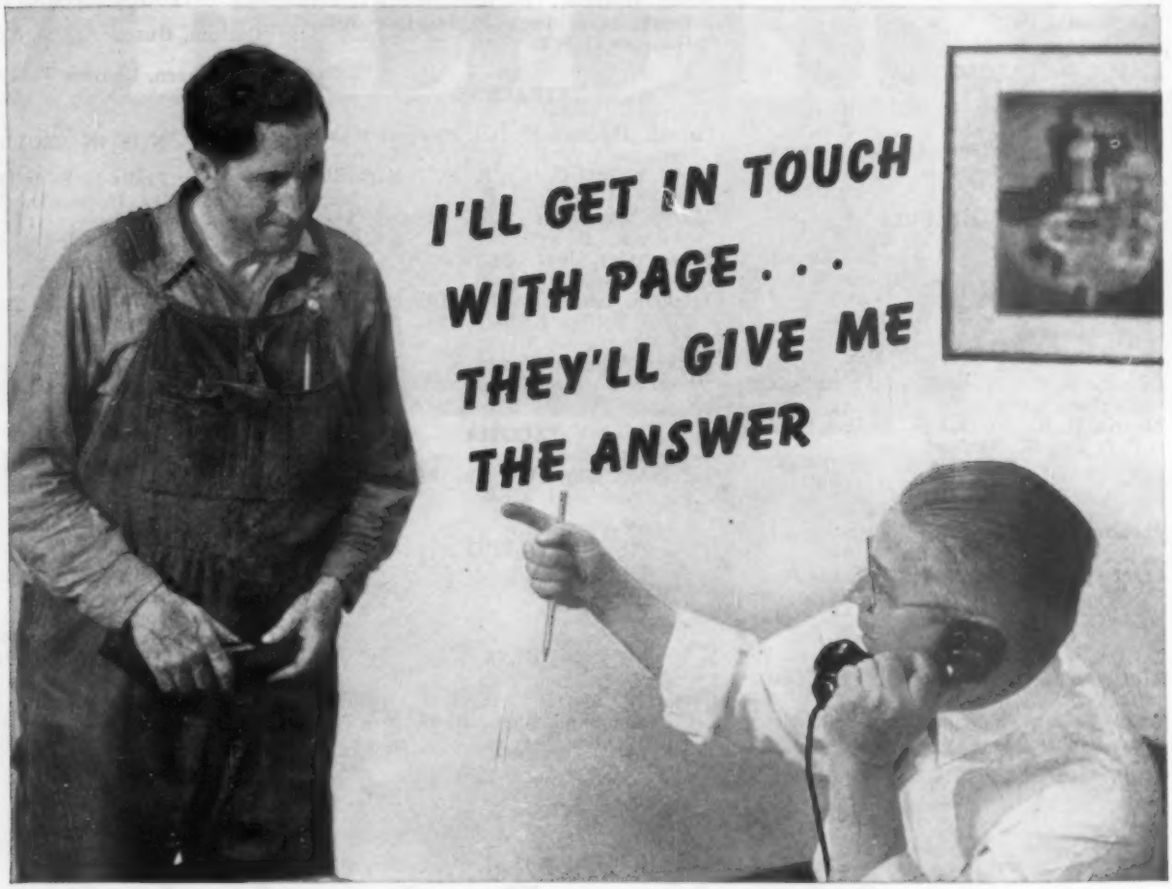

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Spencer, Claude E. (B), Stanolind Pipe Line Co., Stanolind Bldg., P. O. Box 591, Tulsa 2, Okla.

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Williamsen, Charles T. (C), 759 Priority Rd., York, Pa.

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Buchanan, William H. (B), Dymonhard Corp. of America, 24 Northumberland Ave., Roanoke, Va.
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Jackson, H. (B), Thompson Pipe & Steel Co., Larimer & 30th St., Denver, Colo.
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Madsen, K. K. (B), c/o Aktieselskabet ESAB, Trekronergade 92, Copenhagen-Valby, Denmark.
Marx, M. (C), Appin Castle Hill Rd., West Pennant Hills, N. S. W., Australia.
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Schmuck, H. K. (B), The Linde Air Products Co., 2101 Blake St., Denver 2, Colo.
Stannius, Raymond (B), Laboratory Master, Technic School, Odense, Denmark

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During Month of February

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Sturm, Edgar (from C to B), 239 Fowler Ave., Jersey City 5, N. J.

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Pesznecker, Leo C. (from C to B), 8038 S. E. Ogden St., Portland, Ore.

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